8-2001

An analysis of the effect of logistics involvement in cross-functional integrated new product development projects

Zach G. Zacharia
University of Tennessee

To the Graduate Council:

I am submitting herewith a dissertation written by Zach G. Zacharia entitled "An analysis of the effect of logistics involvement in cross-functional integrated new product development projects." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Business Administration.

John T. Mentzer, Major Professor

We have read this dissertation and recommend its acceptance:

Mary C. Holcomb, James H. Foggin, Michael J. Stahl

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Interim Vice Provost and
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AN ANALYSIS OF

THE EFFECT OF LOGISTICS INVOLVEMENT

IN CROSS-FUNCTIONAL INTEGRATED

NEW PRODUCT DEVELOPMENT PROJECTS

A Doctoral Dissertation Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Zach G. Zacharia

August 2001

DEDICATION

This dissertation is dedicated to my wife

Sunitha Kurian Zacharia

and to my parents

George Zacharia and Mariamma Zacharia

ACKNOWLEDGEMENTS

There are many people to whom I am grateful for their encouragement and guidance during the entire process of this dissertation research. I have benefited greatly from interacting with the faculty and fellow doctoral students in the Department of Marketing, Logistics and Transportation at the University of Tennessee. I am indebted to my Dissertation Committee, Dr. John. T. Mentzer, Dr. Mary C. Holcomb, Dr. James H. Foggin, and Dr. Michael J. Stahl for their expertise, support, and encouragement. I am particularly grateful to Dr. John T. Mentzer who chaired the Dissertation Committee whose expertise, guidance and support was a vital reason in being able to complete this dissertation.

I would like to thank Dr. Stephen H. Richards, the executive director of the Center for Transportation Research whose encouragement and willingness to accommodate my school schedule made it possible to work full time while I pursued my Ph.D. I am grateful to Ms. Mollie C. Mitchell who assisted me with both my work responsibilities and dissertation requirements. Additionally, to all my family and friends who have encouraged me, prayed for me and brought joy into my life I wish to say thank you all.

Finally, the greatest debt is owed to my wife, Sunitha; my children, Keziah, Aaron and Mikhaila; my parents, George and Mariamma; and my sister Mary whose love, encouragement, support and unwavering belief in me made it possible for me to continue towards completion. To each of them, Thank You!

ABSTRACT

The primary purpose of this dissertation was to empirically test the relationship between logistics involvement in new product development and improvements in new product development project performance and logistics performance. A logistics involvement new product model was developed that contained seven first order constructs: environmental uncertainty, improving information technology, time and quality based competition, global factors, cross-functional integration, new product development project performance, and logistics performance; and two second order constructs, logistics functional salience and logistics involvement.

The research design incorporated an e-mail survey methodology where 1430 logistics executives from American companies were asked to complete a four page survey on a completed new product development project. Structural equation modeling was used to test the statistical validity of the model and related hypothesis. The collected survey data supported six of the 10 hypotheses. Both project performance and logistics performance were found to have improved with the inclusion of logistics in new product development prior to launch. In addition, this dissertation identified environmental factors, such as improving information technology and environmental certainty, lead to greater logistics functional salience within the firm. Additionally, the overall fit of logistics involvement in new product development was supported by a comparative fit index (CFI) of .9074.

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CHAPTER 1

INTRODUCTION

This dissertation brought two streams of research together in an attempt to improve the New Product Development (NPD) process for durable goods manufacturing firms. One stream of research considered contingency theory in organizational behavior research, which suggested that behavior within an organization is dependent on many factors, including the environment. A second stream of research looked at Cross-Functional Integration (CFI) in product development - the involvement of more than one function concurrently in product development. This dissertation used the literature that existed within both these streams to develop a model of early logistics involvement (defined as pre-launch involvement) in new product development. The basic intention was to develop a framework that could be used to analyze the key factors and potential challenges that are associated with the early involvement of logistics as part of a Cross-Functional team in new product development. It was hoped the model developed could be used to provide guidance to logistics practitioners and researchers in early logistics involvement in NPD.

NPD has been an important formal concern of business organizations for well over 40 years and is still relevant, especially with shorter product life cycles and momentous technological changes. Booz, Allen and Hamilton, Inc. (1982)

found that over a five-year period, new products accounted for twenty eight percent of the growth of the companies surveyed.

Even though NPD has been studied for such a long time, there is still much to understand in the process as companies continue to have spectacular new product failures. Booz, Allen and Hamilton (1982) found the failure rate of new products introduced between 1963 and 1981 was as high as thirty-five percent, which was later confirmed by another survey (Cooper 1990). What is NPD and why is it important? At what stage of NPD does logistics currently get involved? Are there any improvements in new product project performance or new product logistics performance with the early involvement of logistics in the NPD process? The answers to these questions using a review of the NPD literature and the testing of a new model relating early logistics involvement (ELI) and NPD are presented here.

THE IMPORTANCE OF NEW PRODUCT DEVELOPMENT

Today's climate of new product development is characterized by increased domestic and global competition, continuous development of new technologies that make existing products obsolete, changing customer requirements which truncate product life cycles, rising product development costs and an increasing dependence on external organizations (Gupta and Wilemon 1990). The business environment of the 1990's can be characterized as increasingly dynamic in terms of increasing technological complexity, demanding markets, explosion of knowledge and increasing global competition (Peter 1996). To survive and grow in this competitive arena, companies have had to look at ways to improve their new product development process. Successful innovation and new product development are important for the growth and long term health of the organization (Calantone and Benedetto 1988; Cooper and Kleinschmidt 1991). A continuous flow of new products is the lifeblood of an organization (Barczak 1995). Successful new products help companies develop new markets, as well as cater to the emerging needs of existing markets (Nakata and National 1996). The successful launch of new products is critical to maintaining market leadership (Rangan, Menzes and Maier 1992). Up to a third of the financial growth in companies is a direct result of new products (Dean and Okonkwo 1989). A firm's ability to respond quickly to changing customer needs through the rapid introduction of new products is now being touted as a key strategic differentiator (Birou and Fawcett 1994). In the 1970's new products accounted for twenty percent of the companies profits; by the 1980's profit combinations of new products rose to over thirty percent (Takeuchi and Nonaka 1986), and this was expected to increase in the 1990's. Welter (1989) stated in the 1990's the average company would generate forty percent of its sales from products less than five years old.

The importance of time-based competition (Stalk 1988) is also beginning to be recognized as a source of competitive advantage. Firms introducing high-tech products six months past the projected release date, but within budget, realized a thirty-three percent decrease in expected profit over the next five years. On the other hand, firms introducing products on time, fifty percent over budget, suffered only a four percent reduction in profits (Gupta and Wilemon 1990). This research was replicated later by Gupta and Souder (1998) and demonstrated companies that had short cycle times for new products: (1) extensively involved customers and suppliers in their new product R&D processes, (2) adopted a product design philosophy that encouraged the development of future innovations at low cost, (3) incorporated manufacturing concerns at the design stage, (4) tested new products in user facilities during their development, and (5) had well-developed procedures for transferring learning from one project to another. Short-cycle-time companies were also more profitable than longer-cycle-time companies and exhibited new product success rates above their industry averages, thus demonstrating that short-cycle-time management pays off on the bottom line. The development cycle time for a new product is the elapsed time from its ideation to product launch (Gupta and Souder 1998). Time pressures have become more critical as delay in delivery of new product innovations can cost firms significant proportions of related profits but just focusing on speed to market may miss the point in that the real challenge is how to create faster, better and cheaper products, not just create them faster (Wind and Mahajan, 1997). Interestingly, project teams with greater representation of interest groups appear to increase the speed of product development (Kessler and Chakrabarti 1996), which provides support to the concept of integrated development through cross-functional teams that will be developed further in this dissertation.

Respondents to a survey conducted by Gupta and Wilemon (1990) identified several contributing factors to the need for accelerated development of new products: (1) increased competition, (2) rapid rate of technological change, (3) consumer demand for new products, (4) shortened length of the Product Life Cycle, and (5) the desire to be first to the market. Even though there is a focus on accelerating the NPD process, it must be noted that customers still demand the products must meet the requirements of high quality and value. Clearly, for companies to grow and prosper in the highly competitive business environment of the future, an effective and efficient NPD process needs to be in place.

NEW PRODUCT DEVELOPMENT DEFINED

New product development is defined as "the process of conceiving and creating a new product and the outcomes of that process"(Nakata and National 1996; Sheremata, 1998). There are many different ways to delineate the process associated with NPD that can range anywhere from two to ten steps (Kuczmarski 1992) to thirteen steps (Cooper 1985). For the purposes of this dissertation a seven stage model adapted and modified from Song and Montoya-Weiss (1998) and Gupta, Raj and Wilemon (1986) was used. The seven stages include: (1) Idea Generation, (2) Idea screening, (3) Business and market opportunity analysis, (4) Product development, (5) Product testing, (6) Product launch, and (7) Post launch. The first five stages can be broadly categorized as pre-launch and the remaining two as launch and post launch, respectively. This dissertation focused primarily on pre-launch activities. These NPD stages can be seen in Figure 1.1 - New Product Development Stages.

TYPICAL NEW PRODUCT DEVELOPMENT STAGES

According to Hall (1991), new products and services can be classified into five categories: (1) the break-through product, (2) the "it's new for us" product, (3) the new improved, next-generation product, (4) the line extension product, and (5) the three R's (repackaged, repositioned, recycled). Meyers and Tucker (1989) developed another classification system based on the process of developing and introducing a new product or service: (1) Radical Innovation - the market is unfamiliar with the product class and technology, (2) Routine Innovation - the market is familiar with the product class but the technology is new, (3) Market Modification - the technology is well known but users are unfamiliar with the product, or (4) Product Modification - neither the market nor the technology is new.

Unfortunately, although NPD is so important, many of the NPD processes used currently are not very successful. Only one new product development project in four becomes a winner and almost fifty percent of the resources American firms

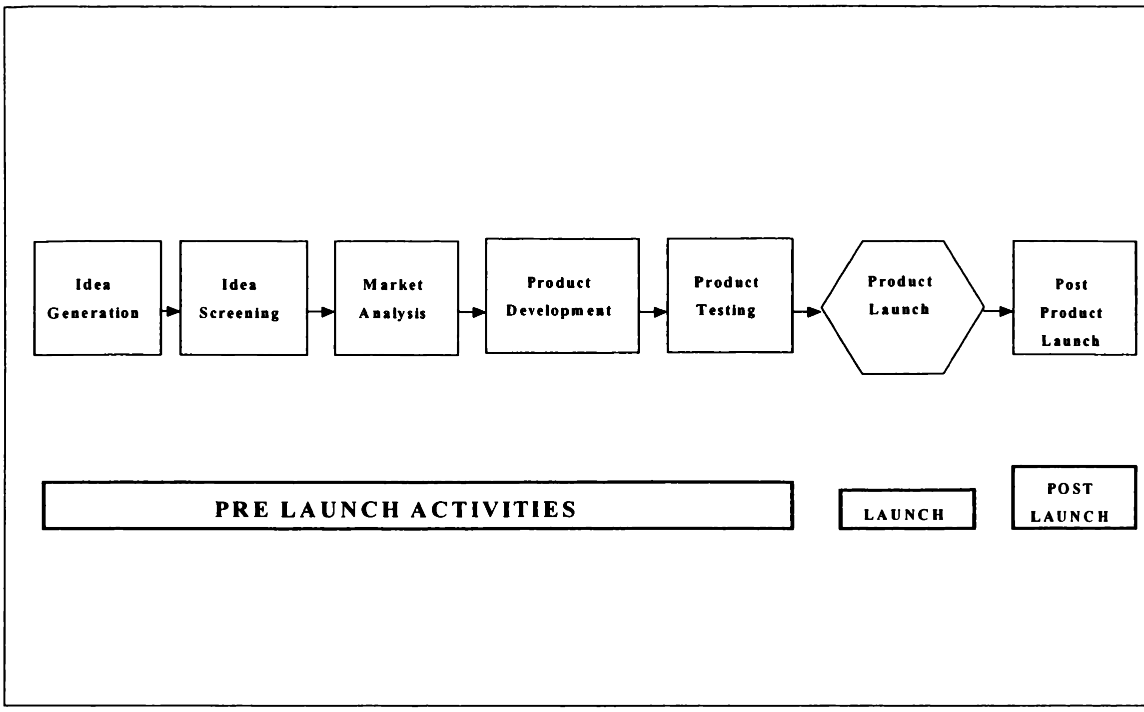

FIGURE 1.1 Typical NPD Stages

devote to innovation are spent on products that are commercial failures (Cooper 1990). Many firms continue to neglect the organizational integration required for successful product development or overlook important activities during their NPD process (Millson 1993). Technological development waves are becoming shorter and shorter, which means product life cycles also are becoming shorter (Topfer 1995). As product life cycles get shorter and technology seems to change at an ever-increasing pace, it becomes especially critical to have an effective, efficient and successful new product development process. Therefore, the scope of the NPD process encompasses the delivery of a high quality, cost-effective product incorporating the latest technology in the shortest time from concept to market (Birou and Fawcett 1994).

NEW PRODUCT DEVELOPMENT PROCESSES

There have been a number of different research streams in new product development research that led to specific approaches to improve and accelerate the new product development process - integrated product development (Birou and Fawcett 1994), cross-functional teams, physical co-location (Kahn and McDonough 1997; Raffi 1995), concurrent engineering (Swink, Sandvig and Mabert 1996), early supplier involvement (Peter 1996; Birou and Fawcett 1994), stage gate systems (Cooper 1990), return map (House and Price 1991), and quality function deployment (House and Price 1991). Many of these approaches focused on the specific roles played by the various functions in the firm during new product development.

The first research stream looked at the organization and how the external and internal environment affected the behavior within the organization. Organizations have the capability to change themselves in basic ways depending on the external environment that the organization is in (Lawrence and Lorsch 1967). This leads to the concept that as the environment changes, different functions within the organization tend to have greater or lesser influence within the organization. This is the concept of how a function becomes more or less important (functional salience) depending on the needs of the organization as shaped by the environment. Highly uncertain environments require a different type of structure within the organization than do stable environments.

The second research stream considered is associated with the specific roles played by R&D, marketing, manufacturing and logistics. This stream can be broadly divided into a cross-functional (involving more than one function) product development approach or a sequential product development approach, where functions such as R&D, marketing, manufacturing and logistics work independently and in sequence. For example R&D develops the new product, marketing tests the product, manufacturing produces the product and logistics distributes the new product. In cross-functional development, R&D, marketing, manufacturing or logistics work together in some fashion. Researchers have postulated there is a relationship between successful NPD and the degree of cross-functional integration that exists during the NPD process between the marketing and R&D functions (Gupta, Raj and Wilemon 1985). Other researchers have suggested all of the firm's functional departments need to be integrated during the NPD process (Ruekert 1987a). It has also been pointed out that a cooperative organizational climate does not assure NPD success but such a climate does appear to be a facilitator (Capon, Farley, Lehmann and Hulbert 1992). There exists a substantial literature base on integrating marketing and R&D and a much smaller literature base for integrating manufacturing with marketing and R&D in the NPD process. There is very little

NPD literature that considers the role of logistics in NPD or integrating logistics with marketing, R&D and manufacturing.

Internally, logistics interfaces with manufacturing, marketing and R&D when dealing with procurement, inventory, warehousing and distribution (Morash, Droge and Vickery 1996). Externally, logistics interfaces with customers (when delivering the product or providing spare parts and warranty support) and suppliers (through purchasing and the incoming movement of goods). The practitioner literature seems to extol the virtue of early supplier involvement, especially in the automotive industry. A significant portion of the success of Japanese companies can be attributed to the impact of their relationship with the supply base and the early and extensive involvement of their suppliers in NPD (Clark 1989). Logistics typically gets involved in new product development after the product has been developed and it needs to be distributed in the launch phase. Early logistics involvement suggests that logistics should be involved in pre-launch activities such as idea generation, idea screening and product development. Very little published research considers the role of logistics in NPD and the role of logistics in the pre-launch phase of NPD.

This dissertation addressed two critical gaps in logistics and marketing research. The first gap, found in the logistics literature, was the lack of research in new product development. Logistics is in a unique position to span the many boundaries that exist internal and external to the firm that could be advantageous in the NPD process. The logistics literature is filled with many articles identifying the advantages of looking outside the boundaries of the company, incorporating input from suppliers and customers to develop more efficient distribution, transportation, purchasing and inventory processes. This process of going beyond functional boundaries within the company and going beyond company boundaries and incorporating customer and supplier input could be used to develop a more efficient NPD process.

The second gap, found in the marketing NPD literature, was the lack of research that examined the role logistics plays in the NPD process. The new product literature has started to embrace the concepts of integrated product development among the many functions within the firm. Marketing has always focused on incorporating the voice of the customer, R&D has focused on incorporating the latest technological advances, and manufacturing has focused on maximizing efficiency of the production process. This was an opportunity for logistics to bring the voice of the supplier and the customer and the benefits of thinking about procurement, inventory, warehousing and distribution issues early into the NPD process.

RESEARCH PURPOSE

The purpose of this research was to develop an understanding of the role of logistics in the NPD process, specifically early logistics involvement that utilized a cross-functional product development strategy and how that impacted the success of a new product development project. This led to the following research questions:

(1) As the environment changes does logistics as a function become more important?

(2) Do companies that have a cross-functional NPD process in place have greater NPD project success with logistics involvement?

(3) Do companies that rely on logistics for competitive advantage or where logistics is an important function benefit from direct logistics involvement in the NPD process?

(4) Does early logistics involvement in the NPD process affect project performance?

(5) Does early logistics involvement in the NPD process affect logistics performance?

(6) Does early logistics involvement effect on project performance depend on the level of innovation?

(7) Does early logistics involvement effect on logistics performance depend on the level of innovation?

RESEARCH SCOPE

This research focused solely on the role that logistics plays in new product development in a cross-functional product development process. The new product development process includes all the steps identified earlier. This dissertation does not consider the strategic planning phase before idea generation or the process associated with the diffusion of innovation in the marketplace after product launch. The term new product in this dissertation was assumed to include new services and no attempt was made to distinguish between the two. The new product development process in this dissertation did not use a company wide perspective but rather used a single product/project perspective that is similar to much of the research in the new product development literature.

RESEARCH METHODOLOGY

This study used essential constructs and relationships from two different streams of research, contingency theory and cross-functional product development. This study developed and tested an exploratory integrative model that illustrated the relationships between early logistics involvement and new product development.

A survey method was used to collect the data because it fulfilled the needs of (1) covering a broad range of issues, (2) extensively analyzing and testing the hypotheses through statistical techniques, (3) collecting perceptual data from a larger population (Marshall and Rossman 1989), and (4) obtaining relatively accurate information within sampling error (Kerlinger 1992).

ORGANIZATION OF THIS DISSERTATION

This research study consists of a literature review, the description of the proposed study, the discussion of the empirical study results, and the potential contributions and limitations of the study. Chapter Two begins with a brief review of the organizational behavior literature to further define the concept of functional salience. The new product development literature is then briefly reviewed starting with a history of how cross-functional product development has become popular in NPD starting with integrating marketing and R&D and then integrating manufacturing, marketing and R&D. The current role of logistics in NPD internal to the company and external to the company is then discussed. The concept of integrating logistics with marketing, R&D and/or manufacturing is discussed. This leads to the development of a model that considers early logistics involvement in new product development. The goal of this literature review is to relate logistics to early involvement in NPD, both internal and external to the company. This is followed by a description of the constructs used in the research, a proposed conceptual model, and a set of hypothesis is offered.

In Chapter 3 the research methodology for testing the hypotheses developed in Chapter 2 is presented. In Chapter 4, the results from the survey are analyzed. The results of the statistical hypotheses testing, analysis of reliability and validity of the measures with the final data are also provided. In Chapter 5, the conclusions and implications of the results are presented. The contributions, limitations, benefits and future research implications of this study are provided.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the organizational behavior, marketing, R&D, manufacturing and logistics literature to identify the major constructs and research trends that were used in this dissertation. The first section reviews the organizational behavior literature to identify related research streams in contingency based theory that leads to the concept of functional salience. The second section reviews new product development research in the marketing literature and categorizes this literature into three major research streams. The third section reviews the advantages and disadvantages of involving more than one function in new product development - the concept of cross-functional integration. The fourth section considers integrating the marketing function with R&D in an NPD process. The fifth section considers research literature associated with integrating manufacturing with marketing and R&D in an NPD process. The sixth section reviews the role of logistics both internal and external to the firm and the new product development process. This led to the idea of a cross-functional product development team made up of marketing, R&D, manufacturing and logistics. The seventh and final section considers the role of logistics prior to product launch, or early logistics involvement.

CONTINGENCY THEORY

The basic premise of contingency theory in Organizational Behavior research is that there exists a wide variety of factors, all in combination with each other, that influences behavior in organizations (Pennings 1992). Contingency theory, as developed primarily by Lawrence and Lorsch (1967), suggests the act of segmenting the organization into departments influences the cognitive orientation and behavior of organizational members in important ways. Lawrence and Lorsch (1967) proposed organizations have the capability to modify themselves in basic structural ways and are highly interdependent within the environment. The two terms they use to describe the behavior of functions within the firm are differentiation and integration. Differentiation is the "the state of segmentation of the organizational system into subsystems, each of which tends to develop particular attributes in relation to the requirements posed by the external environment" (Lawrence and Lorsch 1967 p3-4). Integration is "the process of achieving unity of effort among the various subsystems in the accomplishment of the organization's task" (Lawrence and Lorsch 1967 p11). These research streams are identified in Figure 2.1 – Related Research in Contingency Theory.

Highly uncertain environments require a different type of organizational structure to produce effectiveness than do stable environments. But not all sectors of the environment are uniformly stable or uncertain. Since functions within the

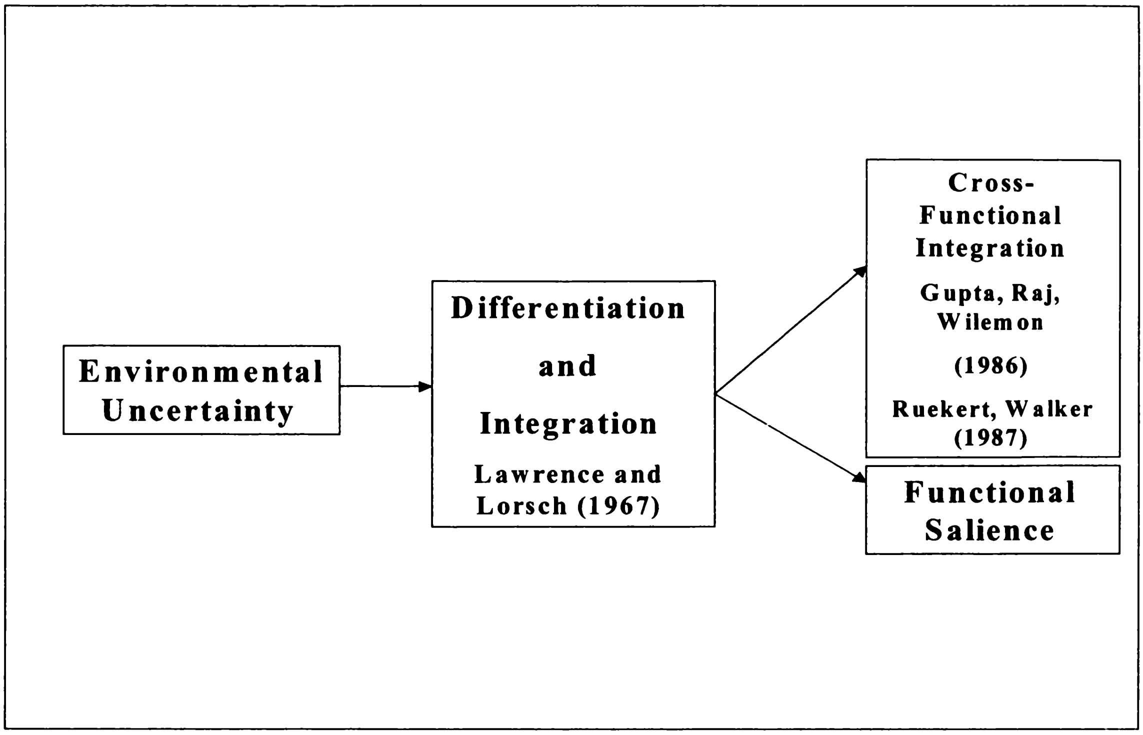

FIGURE 2.1 Related Research In Contingency Theory

organization have responsibility for dealing with different sectors of the environment, effective adaptation at the level of the function will result in differentiation at the level of the organization. Integration will become more problematic in more highly differentiated organizations by virtue of the greater differences in cognitive, emotional and behavioral orientations of the different functions.

Conflict will invariably rise between functions depending on the degree of integration and differentiation that is needed for a particular environment. Lawrence and Lorsch (1967) suggested the influence among the groups will vary depending on which functions have knowledge or certainty of information about particular environmental conditions. This suggests the importance, or salience, of particular functions within the organizations will change as the environment changes. Even though Lawrence and Lorsch (1967) do not explicitly use the term functional salience, they do suggest the influence of different groups will change as the environment changes. This leads to the introduction of the concept of functional salience that varies as the environment changes because, as Lawrence and Lorsch (1967) pointed out, organizations will change to best meet the needs of its members and the demands of the environment.

Lawrence and Lorsch (1967) studied the interaction among sales, production and R&D in a number of firms to identify the concept of the changing influence of each function within the firm as the environment changes. The environment varies along a certainty–uncertainty continuum and different organizational structures are appropriate for either end of the continuum. In a stable, certain environment there will be a high degree of reliance on formalized rules, short time horizons of the managers, and task oriented interpersonal style, while in an uncertain rapidly changing environment the organization will have very few formal rules, long time orientation and relationship oriented interpersonal style (Lawrence and Lorsch 1967). As the relevant environment continues to change, different functions within the organization and the organization itself will change to best match the opportunities within the environment.

Two important outcomes of this research are utilized by this dissertation. One concept is the idea of functional salience, a new term, which for the purpose of this dissertation will be defined as the importance (salience) of each function within an organization, which will vary depending on changes in the relevant environment. The second concept is the idea of cross-functional integration among the various functions to best meet the needs of the organizational task.

It should be noted that other researchers in organizational structure research did show that environmental uncertainty, or the environment in general, is only one of many variables that may influence organizational complexity. The most significant other factors affecting organizational structure include organization size, technology, culture and strategic choice (Hall 1987). Miner (1980), after reviewing research in this area, noted that one of the few consistent findings is that more integrated firms are more effective irrespective of their environments. Therefore, the amount of organizational effort devoted to integration is indirectly contingent on the nature of the environment.

The next section reviews the new product literature in marketing and the concept of cross-functional integration starting with R&D and marketing, then manufacturing, marketing and R&D and finally logistics, manufacturing, marketing and R&D.

NEW PRODUCT DEVELOPMENT IN THE MARKETING LITERATURE

The development of successful new products is a key strategic activity for most firms. Yet new product development projects are inherently risky. A number of studies have examined the process of new product development to identify factors that lead to successful new product development. This literature can also be segmented by a manufacturing (Clark & Fujimoto, 1991; Wheelwright & Clark 1992) or a marketing focus (Dougherty, 1990, 1992; Cooper and Kleinschmidt 1990; Griffin, 1997; Wind & Mahajan, 1997). Brown and Eisenhardt (1995) developed a schema for classifying the work in the new product literature into three distinct research streams (1) rational planning, (2) communication web, and (3) disciplined problem solving (Table 2.1).

Research into product development as a rational plan has assumed that product development is a strategic activity that has to be planned in advance, executed well and have top management commitment to the product. The majority of new product development research fits within this stream. The underlying focus of this stream is to identify, in a broad sense, the correlates of project success.

Research into product development as a communication web focuses on the new product development team and most researchers are interested in investigating the communication pattern of members of the team and their impact on team effectiveness. In particular, communication among team members and

TABLE 2.1

Comparison Of Research Streams In New Product Development

Brown and Eisenhardt (1995)

Concepts	Rational Plan	Communication Web	Disciplined Problem Solving
Key Idea	Success via superior product, attractive market, rational organization	Success via internal and external communication	Success via problem solving with discipline
Theory	Mostly atheoretical	Information and resource dependence	Information including problem solving
Methods	Bivariate analysis; single informant; many independent variables	Deductive and inductive multivariate; multiple informants	Progression from inductive to deductive; multiple informants; single industry, global studies
Product	Product advantage-cost quality, uniqueness, fit with core competence	---------------	Product integrity-product vision that fits with customers and firm
Market	Size, growth, competition	--------------	----------------
Senior Management Project Team	Support Cross-functional, skilled	-------------	Subtle control, Cross-functional
Communication	High cross-functional	High internal, high external – various types and means	High Internal
Organization of Work	Planning and effective execution	--------	Overlapped phases, testing, iterations, and planning
Project Leaders	-------------	Politician and small group manager	Heavyweight leader
Customers	Early involvement	---------------	--------------
Suppliers	Early involvement	--------------	High involvement
Performance (dependent variable)	Financial success (profits, sales, market share)	Perceptual success (team and management ratings)	Operational success (speed, productivity)
Pioneering Study	Myers and Marquis (1969)	Allen (1971)	Imai, Ikujiro and Takeuchi (1985)

communication with external members has been studied. This stream of research is primarily derived from information and resource dependence theories.

Research in product development as a disciplined problem solving stream is the most recent stream of research. Product development is treated as an iterative, problem solving activity with many hit and miss trials and errors before the development of a successful product. The focus of this research tends to be narrow, with the objective of explaining complex phenomena such as product vision, characteristics of heavy weight product leaders and ingredients of an effective product concept.

This dissertation relied on the new product development as a rational plan literature. More specifically, the early involvement of logistics within the new product development team was studied to identify factors that might lead to greater new product success. Within this body of research is a focus on using a cross-functional perspective to analyze new product development success.

Clark (1989), in a study of the auto industry, found integration of the capability between upstream and downstream firms is an important determinant of product development success. On the other hand, Shrivastava and Souder (1987) warn that integration problems can severely inhibit cross-functional new product development and successful technological innovation. Kessler and Charkabarti (1996) argue that integration enables a faster development process. They suggest faster development is associated with lower development cost performance. Thus integration between the functions was proposed as a key enabler to improve development process performance and NPD project success.

In the 1950's and 1960's, and, perhaps, even today, functions such as marketing, R&D, manufacturing and logistics worked independently when developing a new product. This resulted in functional silos working in a linear sequential production process. According to Peters (1988) on the subject of new product development:

> Rip apart a badly developed project and you will unfailingly find 75 percent of slippage attributable to (1) "siloing" or sending memos up and down vertical organizational "silos" or "stovepipes" for decisions, and (2) sequential problem solving.

NPD was viewed as a relay race with each function passing the baton during product development (Cooper 1990). According to the marketing NPD literature there are two models that are primarily used in a sequential NPD process.

In a technology driven model, R&D develops a new and innovative product, manufacturing builds it and then marketing sells it (Van de Ven 1986). Each function works independently. This worked well in the 1950's and 1960's where companies were trying to keep up with demand. Specialization in the assembly line led to lower costs and faster production. Therefore, specializing within each functional group in the NPD process should lead to quicker development. Unfortunately, this did not result in quicker NPD and it certainly did not translate into more successful new products in the marketplace. It is also interesting to note that logistics, or the process of purchasing the raw material and delivering the finished product to the right customer at the right time and right place, was not considered in the new product development schema.

The second sequential NPD model is the customer or needs driven model where marketing comes up with the product idea from customers, which is sent to R&D to prototype and finally to manufacturing to produce (Van de Ven 1986). This has helped in increasing the rate of successful new products, but it still has led to long development times and an inefficient NPD process. In this marketing model, logistics is again not considered explicitly. A new methodology developed to improve the efficiency of the sequential NPD process was to integrate marketing, which provides market needs, with R&D, which provides technological capabilities (Gupta, Raj and Wilemon 1985). Before developing the concept of integrating marketing and R&D, it might be useful to evaluate cross-functional teams in new product development.

CROSS-FUNCTIONAL TEAMS

Many researchers have examined the relationship between cross-functional teams and NPD (Griffin and Hauser 1992, Olson, Walker and Reukert 1995). Having all functions work together should increase knowledge diversity, which should lead to increased idea generation (Stringfellow 1998). Unfortunately cross-functional NPD teams have yielded mixed results in practice (Donenellon 1993; Henke, Krachenberg and Lyons 1993). One of the factors that Cooper (1990) identified as important in NPD was cross-functional team integration. His analysis of 21 companies in the chemical industry with over 103 cases illustrated the team approach really did deliver better results. The key factor to ensure the project stayed on schedule and used time efficiently was having a cross-functional team approach (Cooper 1990). Madhavan and Grover (1998) suggested the reason a cross-functional team is brought together is because its members have collective knowledge that cannot be held efficiently by any of its individual members. However, this collective knowledge is not present by definition when the team is assembled; it is only potentially present. A cross-functional NPD team is a product development vehicle that brings to its task knowledge that is embedded in its members and their interactions as a team (Madhavan and Grover 1998). The potential for new knowledge is embedded in the team and its interactions. The NPD team possesses embedded knowledge; the new product is embodied knowledge. Therefore, the NPD manager's task is to manage the transition from embedded to embodied knowledge (Madhavan and Grover 1998). The rest of the dissertation considers the new product development process as being achieved through the use of cross-functional teams.

INTEGRATING MARKETING AND R&D

The concept of integrating marketing and R&D has been with us for over 30 years. Flournoy (1969) emphasized the need for getting ideas from the market place to the laboratory and other technical people. Crawford (1994) pointed out in his analysis of why new products fail that marketing research (information) was not conveyed to the technical product decision-makers. Marketing talks to customers, analyzes the needs of the market and estimates demand, while R&D tries to keep up with the latest in technology to incorporate into new products. Originally, in many companies there was not enough of a difference between R&D and marketing functions to have an advantage in Cross-Functional integration, but as the R&D and marketing functions became more and more specialized there grew a need to bring both of them back together.

One of the first articles that explicitly stated the importance of integrating R&D and marketing was Gupta, Raj and Wilemon (1985). They pointed out that R&D and marketing integration may be required in all three phases of the innovation process: (1) during the planning phase (establishing priorities and goals, schedules and budgets), (2) during the new product development process (idea generation, idea screening/business analysis, development, testing and commercialization) and (3) the post commercialization phase. Based on a study of over 200 high technology firms, they found a clear relationship between new product success and the level of integration achieved between R&D and marketing.

In 1986, they developed a NPD model that related the degree of integration for which the firm should strive depends on the firm's innovation strategy and the perceived environmental uncertainty within which the firm operates (Gupta, Raj and

Wilemon 1986). What was interesting about Gupta, Raj and Wilemon's (1986) approach was they related the need for integration according to the type of organizational strategy. They used the classification developed by Miles and Snow (1978) that represented the willingness of an organization to enter into new markets with new products and new technologies. Gupta, Raj and Wilemon (1986) felt higher environmental uncertainty with riskier technologies should lead to a need for greater integration between marketing and R&D. They also suggested the ability of a firm to actually achieve the integration is a function of the structure used to coordinate the functions (e.g. centralization, participative decision making) and personnel factors such as sociocultural differences between the different departmental managers. Gupta, Raj and Wilemon (1986) postulated the firm's innovation success is dependent on how well the R&D and marketing integration actually matched what was ideally required. There has been some support for their general propositions that more successful firms in NPD are more effective in integrating marketing and R&D, but this was not correlated to the type of strategy or uncertainty level experienced by the firm (Griffin 1996).

Ruekert and Walker (1987a) also based their analysis of the interactions between marketing and R&D on the Miles and Snow typology. They identified what they thought were the main causes of conflict between marketing and R&D. Marketers were primarily concerned with identifying and catering to customer needs and competitor threats, while R&D personnel focused on issues of technical feasibility and functional effectiveness (Ruekert 1987a).

In a subsequent article Ruekert and Walker (1987b) developed an excellent framework that detailed the interactions between marketing and other functional areas. This model looked at whether interaction and integration are achieved and how they have been achieved in the structural and process dimensions. They also postulated a highly uncertain environment or having an aggressive product/market development strategy would make the functional departments more dependent on each other (Ruekert and Walker 1987b). This, in turn, could increase the level of conflict as greater interaction and resources flowed between the departments. Therefore, it is possible to increase the effectiveness of cross-functional interaction by developing organization structure and coordination mechanisms to speed the flow of resources across departments with strong resource dependencies (Ruekert 1987b). This leads to the idea of using a Cross-Functional integrated product development approach.

In a study of electronic companies, Kahn and Mentzer (1998) found that marketing/R&D collaboration is critical to the success of both marketing and R&D departments. Managers surveyed in both marketing and R&D departments perceived collaboration improved product development performance and should be considered to improve success (Kahn and Mentzer 1998).

It is important to note that just suggesting R&D and marketing should be integrated does not mean it will necessarily happen. There exists a natural tension between marketing and R&D, especially for technical products where the manufactured product must be as good as required by the customer but not as good as technically feasible (Topfer 1995). Too frequently, technology products are over optimized and therefore too expensive from the customer point of view.

There are many barriers to overcome before effective integration can take place between R&D and marketing. The general differences of (1) personality, (2) culture or thought worlds, (3) language or jargon, (4) organizational responsibilities and reward systems, and (5) physical barriers such as physical distances between marketing and R&D mean that communication and cooperation are difficult to achieve in many U.S. firms (Griffin 1996; Song, Montoya-Weiss and Schmidt 1997). Empirical evidence indicates disharmony between marketing and R&D is the rule rather than the exception (Griffin 1996).

Assuming marketing and R&D together are able to develop the final product specifications, the next problem occurs when the plans are handed to manufacturing to produce the product. Poor quality and high product costs have always been blamed on inefficient and ineffective manufacturing practices. Recently, the focus has shifted from blaming manufacturing to initial product design as the primary cause of poor quality and, thereby, poor performance in the marketplace. Forty percent of all quality problems can eventually be traced back to inferior product design (Raia 1989). Some of the recent advances in manufacturing such as lean production, parallel processing and flexible manufacturing also suggest manufacturing should be involved earlier in the NPD process and become directly integrated with marketing and R&D in a cross-functional NPD team. The NPD literature has many articles that discuss integrating marketing and R&D, but very few on the concept of integrating manufacturing with marketing and R&D.

INTEGRATING MANUFACTURING, R&D AND MARKETING

One of the first papers to suggest combining manufacturing with R&D and marketing was Van de Ven (1986) who identified some of the problems in having a linear sequential production model motivated either by technology or market needs, as discussed earlier, and not having manufacturing involved early in the process of new product development. For example, overlooking a design flaw that only showed up when starting full production, not being able to meet scheduled delivery for a critical sub-assembly or extremely tight tolerances in the specifications all lead to poor NPD performance. Quality Function Deployment (QFD) also relied on incorporating customer requirements through marketing with R&D and manufacturing early in the NPD process (Hauser and Clausing 1988).

Another support for the concept of integrating the three functions comes from a study conducted by Szakonyi (1994), who suggested teams made up of marketing, manufacturing and R&D during NPD would lead to greater commercial success. Many practitioners and researchers have noted that new product success rates will increase if firms improve the cross-functional integration among the key functions: marketing, production and R&D (Clark and Fujimoto 1991; Hutt, Walker and Frankwick 1995). Collaboration between marketing, R&D and manufacturing will have a strong positive influence on product development performance (Kahn and Mentzer 1998). In a broad sense marketing can provide input on the needs of the marketplace, R&D can provide input on the latest technology advances, while manufacturing can provide input on potential cost savings in the production process. R&D's concern for an elegant solution could be better balanced with marketing's focus on serving the customer's immediate needs and manufacturing's issues of production efficiency and manufacturability (Raffi 1995). In reviewing the NPD literature, it is interesting to note there are very few articles that explicitly include manufacturing in the process of new product development, yet many of the successful innovations tend to be related to existing or current products. From the earlier definition of successful new products, it can be seen that the majority of successful new products are incremental innovations and not necessarily radical innovations. Manufacturing has an important role to play in this regard.

In a study of electronic companies Kahn and Mentzer (1998) found marketing and manufacturing managers noted collaboration between marketing and manufacturing improved product management performance. In many instances, there can be significant reductions in production cost if manufacturing is able to interact with R&D and marketing early in the NPD process. It is easier to make production cost tradeoff decisions early in the process as to what features need to be kept in the product and what to keep for the next version. Forty percent of all quality problems can be traced back to inferior product design (Raia 1989). The cost incurred during the design stage of the NPD process may be no more than 8 percent of the total product development cost, but the decisions made in this stage determine as much as 60 - 80 percent of total NPD costs (Raia 1989). There is a need for cross-functional integration and working together of all three functions, especially as product life cycles get shorter and time to market becomes more critical.

Unfortunately, the three functions have different objectives - especially in NPD. Manufacturing is rewarded for the achievement of efficiency in production and cost minimization, marketing is rewarded for creating and maintaining markets and satisfied customers, while R&D is rewarded for creating new products (Song, Montoya-Weiss and Schimdt 1997). Marketing and manufacturing have different views on the benefits of collaboration, where marketing focuses on dollar sales goals while manufacturing focuses on cost goals (Kahn and Mentzer 1998). The same problem of personality, culture, language, organizational responsibilities and physical barriers that exist between R&D and marketing as described earlier are exacerbated when manufacturing is added to the mix. Interestingly, Song, Montoya-Weiss and Schimdt (1997), in a study of high technology firms in Mexico, were able to demonstrate that manufacturing, marketing and R&D have highly similar perceptions regarding the determinants and consequences of cross-functional cooperation in the NPD process. This finding suggests all three functions understand the benefits of together developing a new product, but still might have difficulty overcoming the problems associated with working together.

Dowlatshahi (1992) developed the following list as potential advantages of utilizing a cross-functional integrated product development approach: reduction in product development cycle time, avoidance of costly future redesigns, reduction in duplication of effort, better communication and dialogue, more efficient operations and higher productivity, overall cost savings, avoidance of product recalls, lower maintenance costs, more reliable products, better customer satisfaction and improved bottom-line earnings. Takeuchi and Nonaka (1986) suggested the use of a "rugby approach" to NPD, characterized by overlapping the distinct phases of the development cycle to move the process from a strictly linear or sequential flow process to a simultaneous sharing of information.

Assuming marketing, R&D and manufacturing together develop a new product, another problem could arise when trying to deliver the new product. Logistics is the function that is responsible for the inbound procurement, warehousing, inventory control and outbound distribution, as well as spare parts, which can all become very important for the success of a new product (Meyers and

Tucker 1989). Logistics also interfaces with marketing, R&D and manufacturing within the firm. This also suggests that logistics, in the same manner as manufacturing, should be integrated earlier in the NPD process together with marketing, R&D and manufacturing. Before examining the role that logistics can play in NPD, it is useful to consider the roles presently played by R&D, marketing, manufacturing and logistics. In Figure 2.2, the boxes identify the lead function and secondary function in each stage of new product development that is found in most firms today.

INTERNAL LOGISTICS AND NEW PRODUCT DEVELOPMENT

Logistics as a function has been migrating toward integrating procurement,

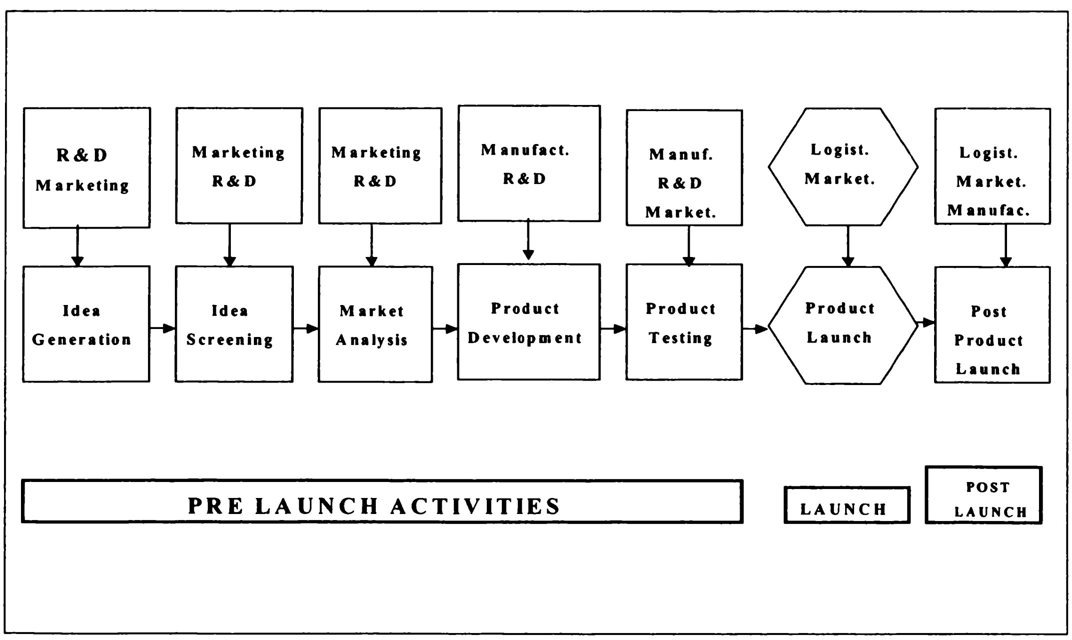

FIGURE 2.2 Lead Roles by Function in New Product Development

warehousing, inventory and distribution. The idea of integrating functional areas within logistics became popular during the late 1970's and early 1980's. The driving force behind this trend was the recognition that sub-optimization occurs if each individual logistics function attempts to optimize its own results rather than integrate its goals and activities with other functions to optimize the results of the firm (Ellram and Cooper 1990). Integrated Logistics Management is the movement of material throughout the firm in an organic and systematic way and that by doing so the effectiveness of the operation can be dramatically improved (LaLonde and Masters 1994). Logistics has become a corporate wide integrated activity in the last two decades (Cooper, Ellram, Gardner and Hanks 1997). Logisticians are used to taking a system wide perspective to make the appropriate trade-off between purchasing costs, transport costs, inventory costs and warehouse costs (LaLonde and Masters 1994). In many cases logistics must work closely with both marketing and production to plan, coordinate, and integrate their cross-functional activities (Morash, Droge and Vickery 1996). Logistics is in a unique interface role with production (manufacturing and R&D), marketing and NPD (Morash, Droge and Vickery 1996). Logistics interfaces with marketing via customer service and manufacturing with regard to product availability, which permits the unique perspective on more effective intra-firm communication and integration (Cooper and Ellram 1993). Kahn and Mentzer (1996), in their analysis of logistics and interdepartmental integration, identified the launch of new products as an example where logistics, marketing and manufacturing need to collaborate closely to meet customer demand efficiently. Logistics managers might consider programs that encourage collaboration with other departments in unusual and/or unstable market conditions like new product introductions (Kahn and Mentzer 1996).

This literature suggests that logistics be directly involved in NPD as it currently plays a key interface role between marketing, R&D and manufacturing. Another way to state all of this is that logistics must serve both the internal customers and external customers of the firm (Langley 1986). External to the company, logistics interfaces with suppliers and customers. Internal to the company, logistics interfaces with marketing, R&D and manufacturing. Many of the articles within supply chain management also discuss the integrating role of logistics within the company (LaLonde and Powers 1993; LaLonde and Masters 1994). Clearly, logistics has an interface role when dealing with marketing, R&D and manufacturing that might be advantageous when developing new products.

Logistics also plays a strategic role in many companies (Mentzer and Williams 2001). Many large retail companies such as Wal-Mart and Benetton compete based on their highly efficient logistics processes. Their strategic and distinctive competency is based on their logistics capabilities. The logistics function within these firms plays a very important role within the firm, or logistics as a function is salient within the firm. NPD projects that require modification to the product line such as line extensions, repackaging, repositioning and recycling or market modification (i.e., incremental innovation) could benefit from having logistics directly involved.

EXTERNAL LOGISTICS AND NEW PRODUCT DEVELOPMENT

The term supply chain management has risen to prominence over the past ten years (Cooper, Ellram, Gardner, and Hanks 1997). Supply chain management can be defined as “an integrating philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user” (Ellram and Cooper 1990). Mentzer *et al.* (2001) specified the nature of a supply chain: "A supply chain is a set of three or more organizations directly linked by one or more of the upstream and downstream flows of products, services, finances, and information from a source to a customer." The focus of supply chain management is beyond the boundaries of the firm, and logistics has an important role to play. The term external logistics is taken from the supply chain literature and is defined as dealing with firms outside the company that include both suppliers and customers.

In a resource-scarce, dynamic environment, in order to maintain flexibility and to benefit from the strengths of suppliers, companies need to build strong, long-term relationships with their suppliers to enable them to bring new products quickly into the marketplace (Gupta and Wilemon 1990). Supplier involvement in new product development is typically identified as early supplier involvement or ESI. The goals of early supplier involvement include a reduction in manufacturing costs, improved manufacturing competitiveness, fewer part numbers and technology transfer (Birou and Fawcett 1994).

The role of suppliers has just started to be researched in the NPD literature, but this research has had mixed results. Researchers such as Birou (1994) suggested ESI is negatively correlated with NPD development success. There was a detrimental effect on product cost, quality, performance and development time (Birou 1994). Peter (1996) suggested ESI should only be considered for a small fraction of products because of the large upfront resources needed from both sides. In direct contrast, Wasti and Liker (1997) in their analysis of 122 Japanese Automotive Component Suppliers found that ESI offers performance benefits for both the supplier and the buyer, especially if technological uncertainty is high. The potential impact of suppliers on the quality and cost of new products is huge considering that fifty-six percent of each sales dollar is spent on the procurement of production materials (Burt 1989).

Ellram (1990) discussed an example of a company that had their suppliers involved in their new product design. This enabled the company to utilize a technology the supplier was still developing. If the company had not had the supplier involved early in the NPD process, the company would have had to wait another three years until their next model introduction to incorporate the new technology.

Another article that discussed the importance of relationships between buying and selling firms, stressed the importance of involving suppliers in joint programs that address key areas of concern to both parties, such as new product development (Monczka, Callahan and Nichols 1995). Logistics can play an important role in the NPD process through either bringing suppliers directly into the NPD team or representing the voice of the supplier in the NPD process. A large percentage of the value-added of a new product is the purchased components and those components have the potential to influence directly not only the cost and quality but also the development time of new products (Birou and Fawcett 1994).

The direct involvement of suppliers in NPD is beyond the scope of this dissertation; instead, it was assumed supplier input was provided through logistics. Logistics can play a vital role in NPD by providing information to reduce the lifetime logistics cost of the new product in terms of distribution costs and service to providing input from both the supplier and the customer. Logistics can facilitate new product commercial success, especially if logistics is able to integrate with marketing, R&D, or manufacturing early in the NPD process.

Vendors and customers have always been a valuable source for new product ideas and it has usually fallen on marketing to provide that input. Logistics can also play a similar role in getting new product ideas, especially product modification and line extensions, from customers. In fact, customer service represents a key link between the traditionally defined marketing function and the logistics area of the firm (Langley and Holcomb 1992). Logistics customer service is significantly related to marketing performance (Morash, Droge and Vickery 1996). Logistics has a role to play in the development of new products that becomes even more critical in industries where time to market is the distinctive competitive advantage. When individual product life cycle times are short, as in the case of style or fashion goods, logistics processes can make critical contributions to the time it takes a firm to bring a new product to market (LaLonde and Powers 1993). As described earlier, logistics can provide to customers the nurturing support a new product needs to ensure commercial success, especially with radical innovation products (Meyers and Tucker 1989).

It should be noted that a risk of early logistics involvement in new product development is the danger of inadvertently signaling the new products to competitors. Logistics, by discussing new product ideas with suppliers, can potentially provide an opportunity for competitors to learn about new products in advance of product launch, which might severely compromise first mover advantages. Porter (1980) noted understanding and sending market signals are an important part of developing effective competitive strategy. Robertson, Eliashberg and Rymon (1995) recounted an example of suppliers providing information to competitors about a company that ordered specialized baking ovens, which indicated a desire by the company to get into the snack market.

Currently in most companies, logistics is not involved in new products until they are developed. Logistics is usually just asked to distribute the finished product. Anecdotal stories abound about the horrors of not having logistics input earlier in the new product development process. For example, an automobile manufacturer spent five years developing a sports utility vehicle but did not communicate the new vehicle specifications with the logistics group till the vehicles were ready to be delivered. Unfortunately, the changed dimensions of the new sports utility vehicles meant the rail cars that were typically used could only carry two racks of vehicles where in the past they had carried three racks. This dramatically increased the cost of shipment per vehicle and increased the delivery time - which could have been avoided with early logistics involvement in NPD.

A research study conducted by Meyers and Tucker (1989) discovered logistics feedback during pre-launch, launch, and post launch influenced new product design and parts configuration based upon reliability, serviceability, shipping, storage, and installation requirements. During the pre-launch phase, logistics made recommendations affecting product design to reduce logistics costs over the life of the product. These recommendations included sourcing spare parts, customers' handling requirements, logistics network capabilities, and data collection and analysis from launch-related tests (Meyers and Tucker 1989). During the launch phase, logistics played a vital role, especially with technological innovations where numerous unknowns made failure unpredictable. Logistics acted as a liaison with vendors, the NPD team, the service team and manufacturing to support the new product and make it a market success (Meyers and Tucker 1989). During the post launch phase, logistics took formal responsibility for the product and continued to be a liaison to the NPD team, R&D, manufacturing and vendors.

Changes suggested by logistics translate to marketplace success as they lead to meeting customer needs more effectively. Logistics plays four important roles in NPD, according to Meyers and Tucker (1989): (1) Advisor - to provide advice about downstream customer participation and product life cycle cost control, (2) Liaison - to liaise between NPD teams and external stakeholders including customers and vendors, (3) Problem Troubleshooter - to capture data, provide analysis and feedback, and (4) Knowledge Library - to provide information on past NPD experiences to NPD teams.

Logistics has long been neglected in the NPD literature. In fact, no matter how well marketing understands the customer, how innovative R&D's design is or how cheaply manufacturing produces it, if the product is not available at the right time, at the right place, in the right condition, at the right cost, the product will not be purchased. "The logistical requirements which ensure the necessary unique combination of packaging, handling, storage and transportation - that is logistics - in many cases doubles the value of the product from the time it is manufactured or grown until it is consumed or used in a further industrial process"(Langley 1986).

Logistics can play a role in post launch activities that can have an impact on early product development. Many times, the NPD literature has only considered the process up to the initial development of the product, but not the consequences of having the product survive in the market place. For long-term commercial success, the product must be adequately supported and nurtured and that is where logistics can play a role (Meyers and Tucker 1989). Logistics could also assist in forecasting (demand, warehouse and distribution requirements), a very important task when dealing with new products after product launch. NPD literature suggests involving manufacturing early in NPD can prevent design problems that lock in poor quality. In the same manner, logistics involved early in NPD can prevent design problems that might affect long term sourcing of parts, inventory or delivery of the product. The diagram in Figure 2.3 shows the relationship among the functions in a new product development team as part of a cross-functional integrated product development approach.

CROSS-FUNCTIONAL INTEGRATED PRODUCT DEVELOPMENT

In the center of this model is a new product development team that would collect new product ideas from logistics, marketing, R&D and manufacturing. This team, made up of members from logistics, marketing, R&D and manufacturing, would meet periodically to discuss new product ideas. Morash, Droge and Vickery (1996), in their research on the furniture manufacturing industry, were able to show

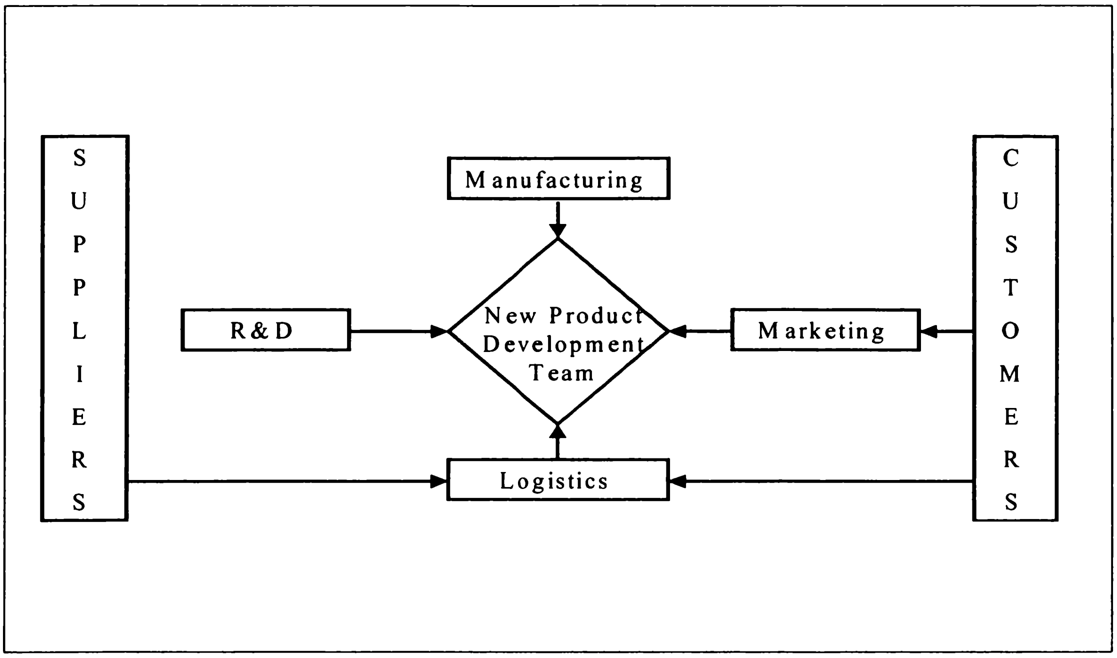

FIGURE 2.3 Integrated New Product Development

that new product development touches all functional areas and all logistical capabilities, yet it is not dominated by any particular area.

The concept of using Cross-Functional Product Development (CFPD) is not new and there are numerous advantages according to the literature. CFPD leads to reduced development lead times with fewer costly redesigns, better communication, reduction in duplication, cost savings from lower maintenance, more reliable products with fewer recalls, and enhanced customer satisfaction (Cooper 1979; Souder 1987; Dowlatshahi 1992). Companies need to stress collaboration between departments to achieve goals collectively and work together as a team (Kahn 1994). By using all four functions from the onset, there is greater likelihood the product will have a market, be technologically advanced, be able to be manufactured and be able to be procured and distributed efficiently, all leading to greater new product commercial success. Analyzing performance results of the furniture manufacturing industry in NPD projects, Morash, Droge and Vickery (1996) found excellence solely in one functional area was not likely the basis for competitive advantage for better performing firms but rather process integration across functional areas. The testing of an integrated product development approach using all four functions concurrently is beyond the scope of this research. Instead, the rest of this chapter focuses on whether the role of logistics early in new product development could affect new product development project success. Figure 2.4 identifies the potential stages in which logistics could provide input in NPD.

EARLY LOGISTICS INVOLVEMENT IN NPD

The literature so far indicates there might be some benefit for logistics to be involved in the new product development process. Unfortunately, it is not clear which specific step in the pre-launch phase would benefit from having direct logistics involvement. Therefore, in this dissertation all five steps as identified in Figure 2.4 were tested to determine if there was a benefit in early logistics involvement.

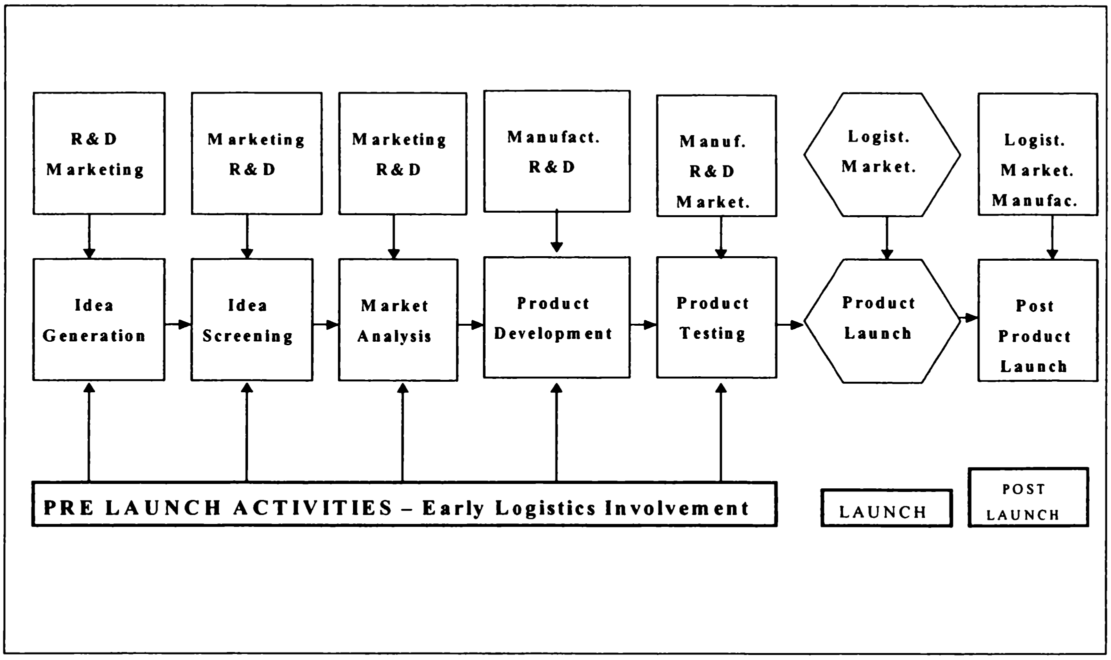

Figure 2.4 Early Logistics Involvement in New Product Development

The first step in the model is idea generation. Logistics could provide new product ideas from integrating purchasing, warehousing, inventory and distribution, plus ideas from suppliers and customers, to the NPD team.

The second step in the model is idea screening. The NPD team would screen the ideas and eliminate those that are not commercially viable. This would allow the elimination of new product ideas for which it is impossible to procure the raw material cheaply, store cheaply, and distribute economically. By incorporating logistics input, there is a greater likelihood of commercial success.

The third step in the model is to do a market opportunity analysis. This is usually done by marketing to develop new product ideas into well-defined sets of attributes that fulfill consumers' needs and desires (Song and Montoya-Weiss

1998). Market opportunity analysis considers the five competitive forces of a market (suppliers, potential entrants, substitutes, buyers, and rivalry among existing firms) which determine the intensity of industry competition and profitability (Porter 1980). Woodruff (1997) also identified the importance of market opportunity analysis and the need to consider the external environment by focusing on demanding customers and superior customer value delivery. Logistics, through its involvement with suppliers in the procurement process and customers during delivery and warranty support, can help provide valuable input. Logistics customer service activities also provide place, time and form utility by ensuring the product is at the right place, at the time the customer wants it and in an undamaged condition (Emerson and Grimm 1996). Clearly, logistics can provide feedback from the customer that would help develop the attributes that are needed for the new product.

The fourth step in the model is product development. This is primarily the responsibility of manufacturing and R&D. This is the stage where the product is designed, engineered and manufactured. Logistics can have a role to play directly in the product development process, especially if it is iterative. Logistics input is especially valuable in this stage of new product development because of its understanding of the supplier and customer needs and its ability to identify the physical product limits associated with suitable storage and distribution.

The fifth and final step in early logistics involvement is product testing. This is the stage where the product, as well as the marketing and advertising program, is tested. New product development by its very nature has to be iterative. During the time lag from initial product idea to a physical product, many things might have changed and at this stage lead users play an important role. Logistics, in dealing with customers directly in the distribution function, can help provide valuable feedback.

The remaining stages of launch and post product launch are stages typical of logistics in the new product development process. Once a new product has been developed, either sequentially or through Cross-Functional integration (CFI), it will go to the customer and enter the market. After the product has entered the market, logistics plays a vital role in supporting the new product to ensure commercial success (Meyers and Tucker 1989). Logistics can also collect feedback from the customers directly to incorporate into the next NPD project.

It is proposed the earlier logistics can be involved in NPD, the greater the likelihood of long-term market success of the new product. The next section develops the models, constructs and hypotheses based on the literature and interviews conducted.

The preceding sections presented the purpose of this research and the background literature. In this section the research model, an operational definition of each construct, the specific dimensions of each construct and the associated measures that were used are presented. Many of the constructs and variables that were used are adapted from the NPD literature (Birou and Fawcett 1994; Cooper 1990) in addition to 21 interviews that were conducted with logistics and new product managers. This led to the development of the overall model as can be seen in Figure 2.5.

The analysis will be based on Figures 2.5 - 2.19 as shown on the following pages. Figure 2.5 shows the overall model with the 12 hypotheses that were tested that relate logistics involvement to NPD project performance.

There are eight first order constructs: environmental uncertainty, innovation level, improving information technology, time and quality based competition, global factors, cross-functional integration, NPD project performance, and logistics performance. There are two second order constructs: logistics functional salience and logistics involvement. It is proposed, in broad terms, that external environmental factors, such as uncertainty, improving information technology, time and quality based competition and global factors, lead to greater logistics functional salience, which in turn leads to greater logistics involvement in new product development. The level of cross-functional integration in the firm and the level of innovation of the new product also affect logistics involvement in new product development. It is hypothesized that logistics involvement in new product development leads to better NPD project performance and logistics performance.

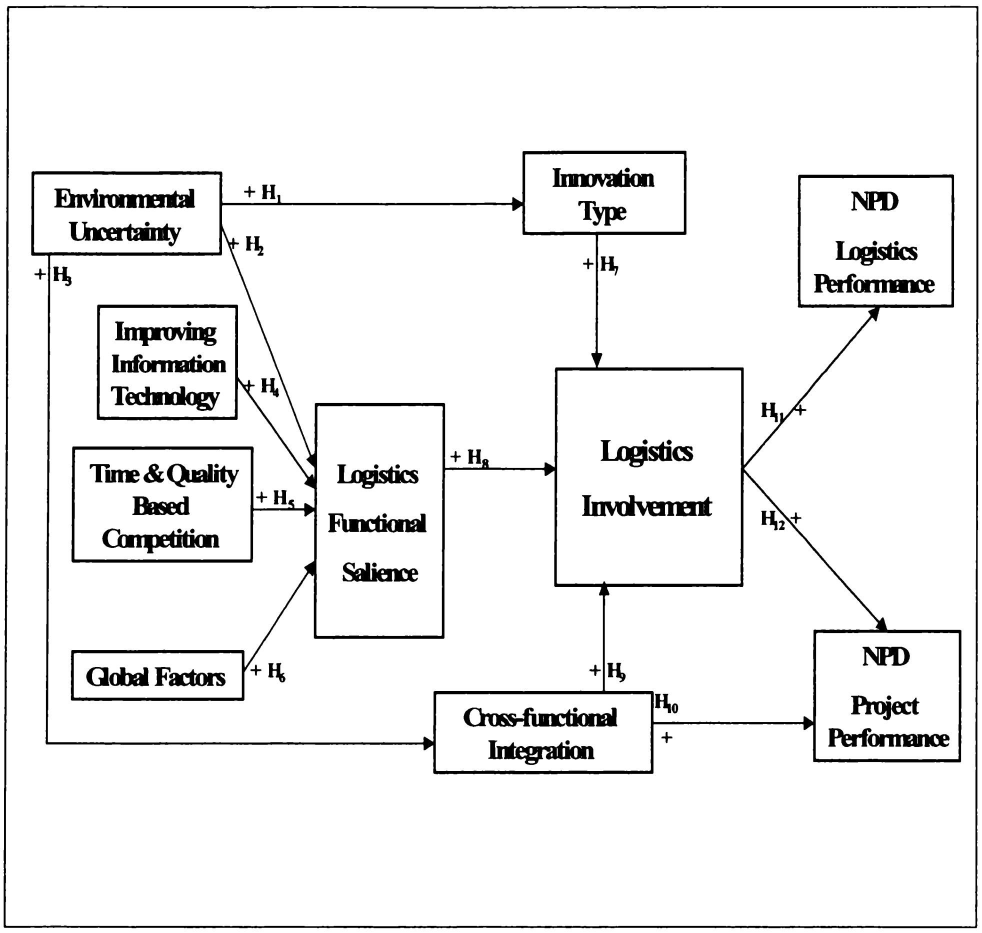

FIGURE 2.5 Logistics Involvement in New Product Development

The following sections will discuss each of the constructs and their associated measures in the context of the relevant hypotheses.

HYPOTHESIS 1

Hypothesis 1 stated an increase in environmental uncertainty will lead to an increase in innovation level, as can be seen in Figure 2.6.

Environmental Uncertainty

Environmental uncertainty has been a mainstay of contingency theory, as described previously, which has long posited environmental factors affect the firm both internally and externally. Several researchers have used the same measure for the construct of environmental uncertainty that was used in the survey (Miller and Droge 1986, Birou and Fawcett 1994, Vickery, Calantone and Droge 1999). The five items that were tested for this construct include Market Changes, Product Obsolescence, Technology Obsolescence, Competitors Actions and Demand Forecast.

Innovation Level

Even though it is possible to categorize new product development projects into several categories, such as the five categories used by Hall (1991) or the four categories used by Meyers and Tucker (1989), this dissertation focused on two categories - radical and incremental innovation. Radical products are break-through products that are new to the market in terms of product class and technology, where

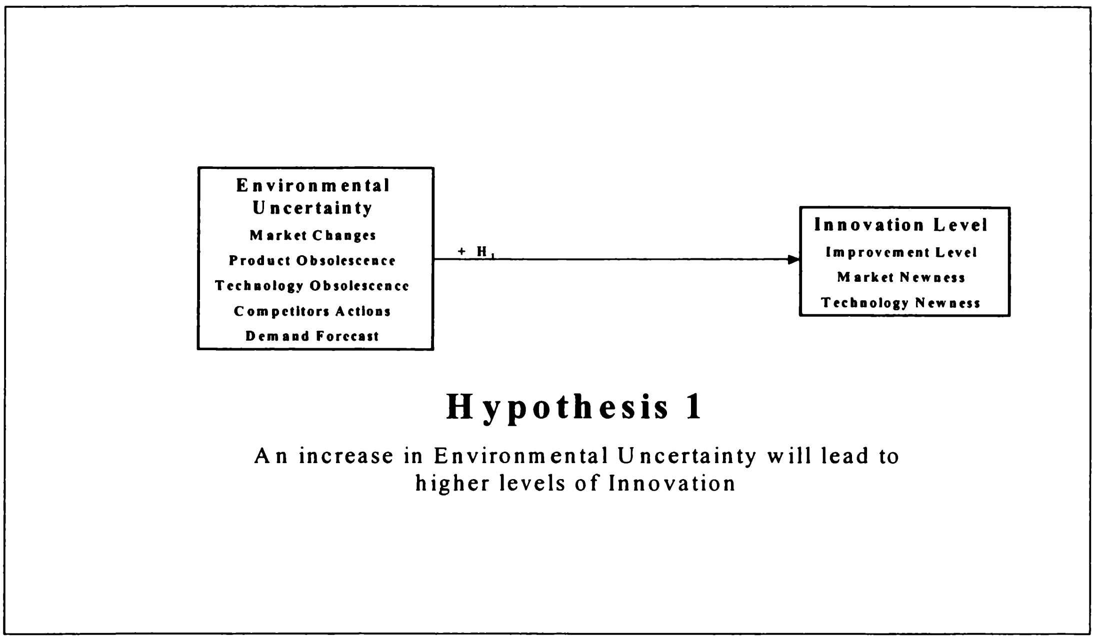

FIGURE 2.6 Environmental Uncertainty and Innovation

target customers are unknown, relying on unproven production technologies (Lynn, Mazzuca, Morone and Paulson 1998, Song and Montoya-Weiss 1998). Radical NPD is characterized by uncertainty, especially with respect to goals and means. The final shape and form of a marketable product are unclear. Radical new product development is difficult, but being able to develop radical new products consistently provides a dynamic capability that is valuable, rare, inimitable and non-substitutable (Teece, Pisano and Shuen, 1994). Incremental products as defined in this dissertation are all other types of innovation, such as products new to the company, line extensions, next generation products, and repackaged, repositioned, and recycled products. The three measures used for the level of innovation Improvement Level, Market Newness and Technology Newness were taken from Meyers and Tucker (1989) and Hall (1991) as can be seen in Figure 2.6.

HYPOTHESIS 2

Hypothesis 2 stated an increase in environmental uncertainty will lead to greater logistics functional salience, as seen by Figure 2.7.

Logistics Functional Salience

Logistics functional salience (LFS) is an important part of this dissertation as described earlier in Chapter 2. LFS provides a rationale for the benefit of having logistics involved in new product development as part of the Cross-Functional team. For the purposes of this dissertation, LFS is the importance of logistics within the firm compared to other functions within the firm. It was felt that logistics as a function has become more important or salient within the firm because of changes in the environment such as an increase in environmental uncertainty,

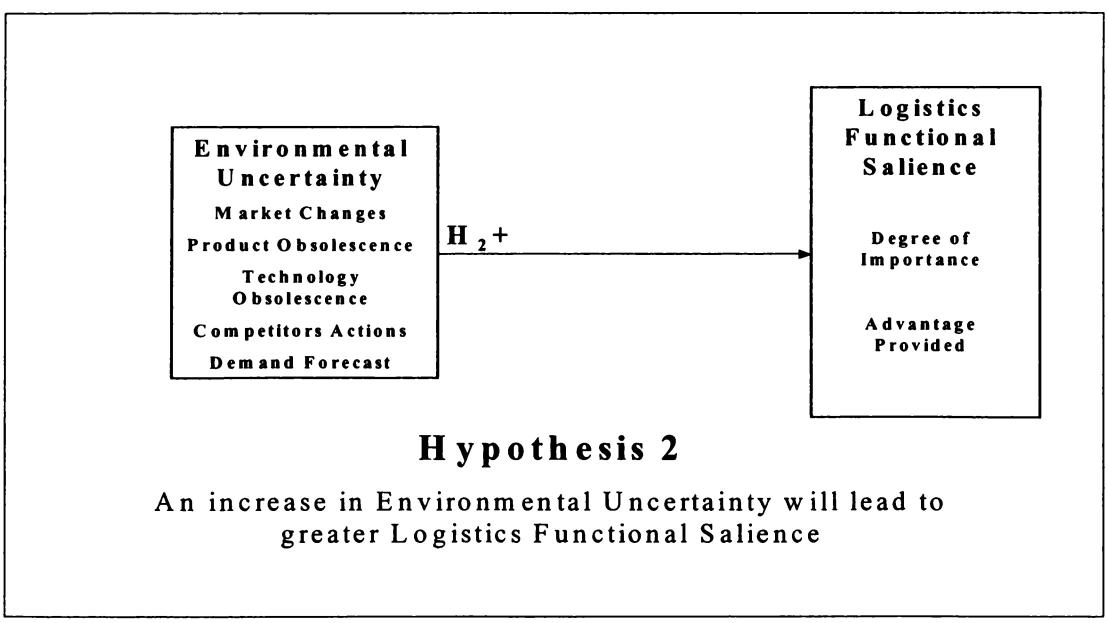

FIGURE 2.7 Environmental Uncertainty and Logistics Functional Salience

improvements of information technology, increase in time and quality based competition, and an increase in global factors.

LFS is a second order construct that is defined by two indicator constructs, degree of importance and advantage provided, as can be seen in Figure 2.8. Degree of importance can be measured by access to top management, decision making influence, visibility within the firm and importance within firm.

Advantage provided can be measured by cost advantage, service quality advantage, competitive advantage and profitability advantage. Degree of access to top management, degree of decision making influence and visibility within the firm were adapted from Forker, Ruch and Hershauer (1999) who were researching the role of the quality department within the firm. Cost advantage, service quality

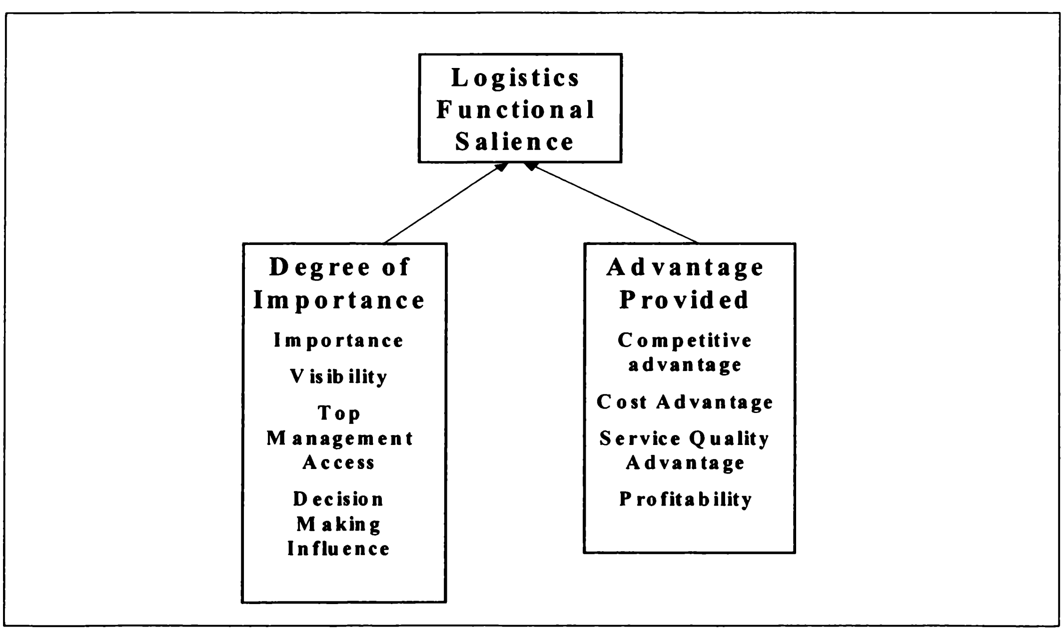

FIGURE 2.8 Indicator Constructs within Logistics Functional Salience

advantage and competitive advantage were adapted from McGinnis and Vallopra (1999 b) who were researching the role of process as a source of competitive advantage within the firm. The other two items were obtained during the expert interviews.

HYPOTHESIS 3

Hypothesis 3 stated an increase in environmental uncertainty will lead to greater cross-functional integration, as can be seen in Figure 2.9.

Cross-Functional Integration

As described earlier, cross-functional integration is the involvement of more that one function concurrently in the product development process. There is no

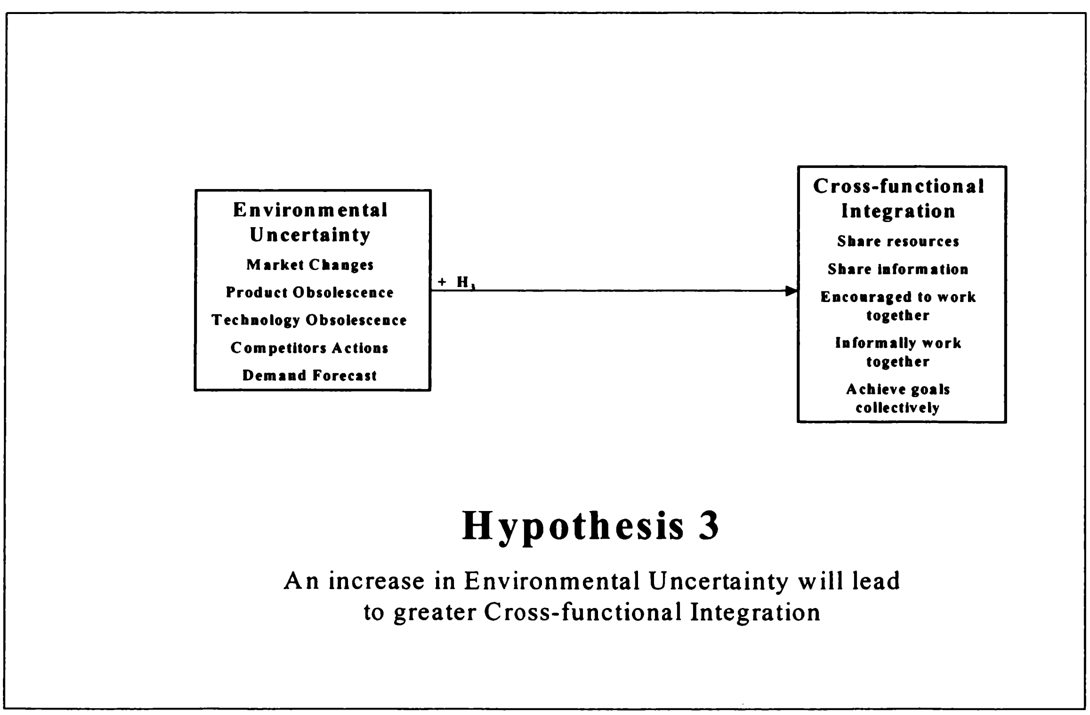

FIGURE 2.9 Environmental Uncertainty and Cross-Functional Integration

attempt to specify logistics involvement, but rather, whether within the firm more than one function works together in new product development. The five measures for Cross-functional Integration are Share resources, Share information, Encouraged to work together, Informally work together and Achieve goals collectively. These five measures were adapted from Kahn (1998).

HYPOTHESIS 4

Hypothesis 4 stated improvements in information technology will lead to greater logistics functional salience, as can be seen in Figure 2.10.

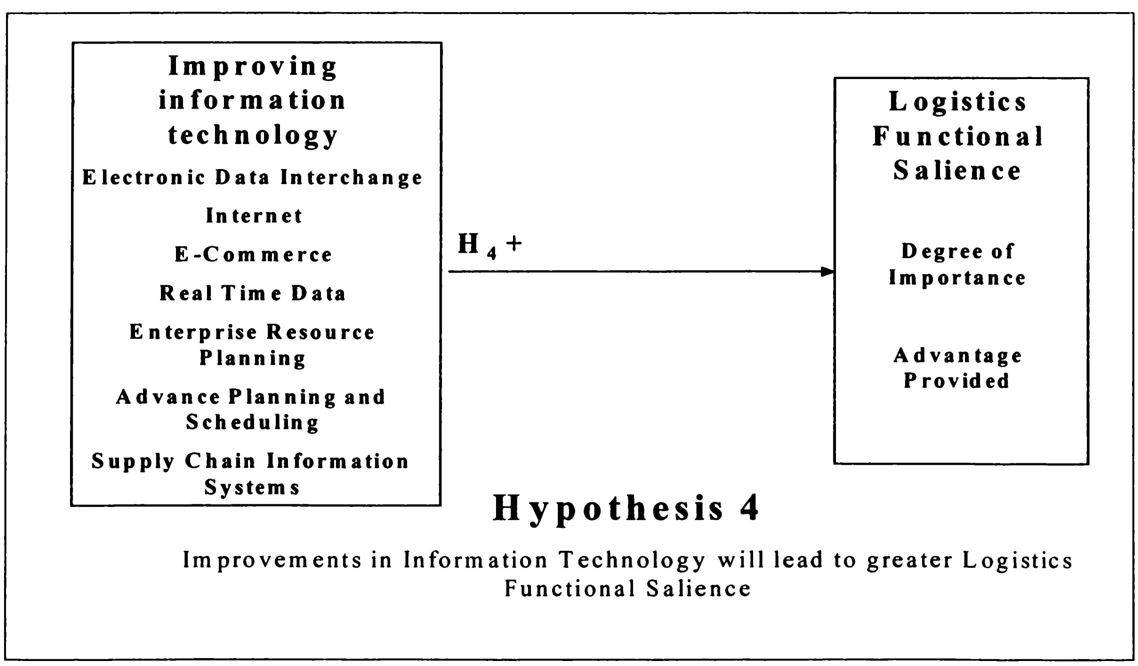

FIGURE 2.10 Improving Information Technology and Logistics Functional Salience

Improving Information Technology

One of the factors that made logistics more important within the firm has been the advances in information technology and the tremendous increase in computing power at very low costs. Information technology offers structural alternatives that facilitate centralized strategic planning and day-to-day execution on a decentralized basis (Bowersox and Daugherty 1995). The evolution of information technology and diminishing transaction costs will lead to a fundamental restructuring of industry practices for distributing and supporting products (Lewis and Talalayevsky 1997). To be efficient, logistics managers need information systems that enable them to be more flexible and responsive (Perry 1991).

Managers have identified information substitution (the intensive use of information to achieve better control and visibility, resulting in lower costs and higher customer service) as a major trend (Perry 1991). Information systems now provide better visibility of physical goods as they move within the firm (Lewis and Talalayevsky 1997). Substituting information for inventory influences strategic decisions and enables significant cost reductions (Rogers, Dawe, and Guerra 1991). Gustin, Daugherty and Stank (1995) found that firms with integrated logistics functions exhibited enhanced information systems performance compared to non-integrated firms. The difference between mediocre and excellent logistics is often the firm's information technology capabilities (Rogers, Dawe, and Guerra 1991).

Internet technology and information systems such as EDI enable value-adding partnerships where the coordination of boundary crossing logistical processes is the key to good logistical performance (Sheombar 1992). Information systems can help reduce the cost of supplier coordination and enhance buyer-supplier relationships. This suggests that information systems play an important role in supplier reliability and supplier partnerships. In this dissertation it was hypothesized that improvements in information technology lead to an increase in importance of the logistics function within the firm.

Through interviews with senior logistics managers and a literature review, seven technologies were identified as indicative of improving information technology. The seven measures for improving information technology are Electronic data interchange (EDI), Internet, E-commerce, Real Time Product Tracking, Supply Chain Information Systems, Enterprise Resource Planning and Advance Planning and Scheduling Systems.

Electronic data interchange (EDI) is one of the more significant changes in inter-firm information systems in recent years (Kahn and Mentzer 1996). Definitions of EDI include “the transmission of standard business documents in a standard format between industrial trading partners from computer application to computer application” (Walton and Marucheck 1997) and "the interorganizational exchange of business documentation in a structured, machine-processable form" (Emmelhainz 1990). EDI has the potential for efficiency improvements due to the availability of complete, timely, and accurate information (Rogers, Daugherty and Stank 1992). The adoption of EDI in the early 1990's grew rapidly because of its alleged strategic potential, especially in the area of logistics (Sheombar 1992) but recent improvements in the Internet have reduced the drive to convert to EDI. Also, EDI can be very expensive and with the increasing focus and ease of access to the Internet, there has been a shift from utilizing proprietary EDI hardware and software to utilizing the Internet.

The Internet (including e-mail) is rapidly becoming a business communication system of choice. The Internet is a low cost method for sharing information both internally (intranets) and externally (Internet and extranet) (Salcedo and Grackin 2000). The Internet, in some ways, has the potential to change the structure of supply chains through facilitating electronic commerce (e-commerce), e-business and e-applications. The Internet represents a new way of developing enhanced relationships with trading partners and customers (Salcedo and Grackin 2000).

Enterprise Resource Planning (ERP) Systems allow companies to replace their existing information systems, which are often incompatible with one another, with a single, integrated system, thereby streamlining data flows throughout an organization and promising dramatic gains in a company's efficiency and bottom line (Davenport 1998). ERP systems have helped companies reduce inventories, shorten cycle times and lower costs, which in turn have helped improve overall supply chain management practices (Minahan 1998). ERP is a good example of improving information technology, which might lead to increasing importance of logistics within the firm.

Increasing sophistication of Internet technologies has led to the development of the electronic market place. Supply chain information systems that facilitate electronic commerce (e-commerce) and e-business applications will become more important as the electronic marketplace gains in popularity, security, and efficiency. Members of the supply chain need access to key business data at any time anywhere in the world, so supply chains will become more and more reliant on storage that resides in networks rather than on the premises of a particular company (Andel 1999). However, ERP systems cannot be directly used for supply chain management or to effectively plan across enterprises (Gould 1998). They have typically been built with an internal perspective and rarely incorporate an external perspective. ERP systems are primarily transaction based and not constraint-based, so they do not take into consideration whether all the resources needed to execute the plan are in place. Supply chain applications, on the other hand, tend to look for bottlenecks that allow users to adjust due dates or resources until they find a satisfactory schedule (Stein 1997). Therefore, supply chain information systems were identified as another item in improving information systems.

An Advance Planning and Scheduling system (APS) is an information system that coordinates the use of firm production, inventory, storage and transportation resources to minimize total supply chain costs (Bowersox, Closs and Stank 1999 p78). The increase in the number of APS systems would be a good indicator of the rise in salience of logistics.

The first five measures for the construct of improving information technology Electronic Data Interchange, Internet, E-Commerce, Enterprise Resource Planning, and Advance Planning and Scheduling were obtained from the literature review discussed earlier. The remaining two measures of Real Time Data and Supply Chain Information Systems were obtained from the interviews that were conducted.

HYPOTHESIS 5

Hypothesis 5 stated an increase in time and quality based competition will lead to greater logistics functional salience, as can be seen in Figure 2.11.

Time And Quality Based Competition

Time and quality based competition can be defined as the elimination of waste in the form of time, effort, defective units, and inventory in manufacturing distribution systems (Mentzer 1998). The importance of time based competition

(Stalk 1988) is also beginning to be recognized as a source of competitive advantage. Product life cycles are shortening and product proliferation is expanding (Fliedner and Vokurka 1997). In this rapidly changing environment,

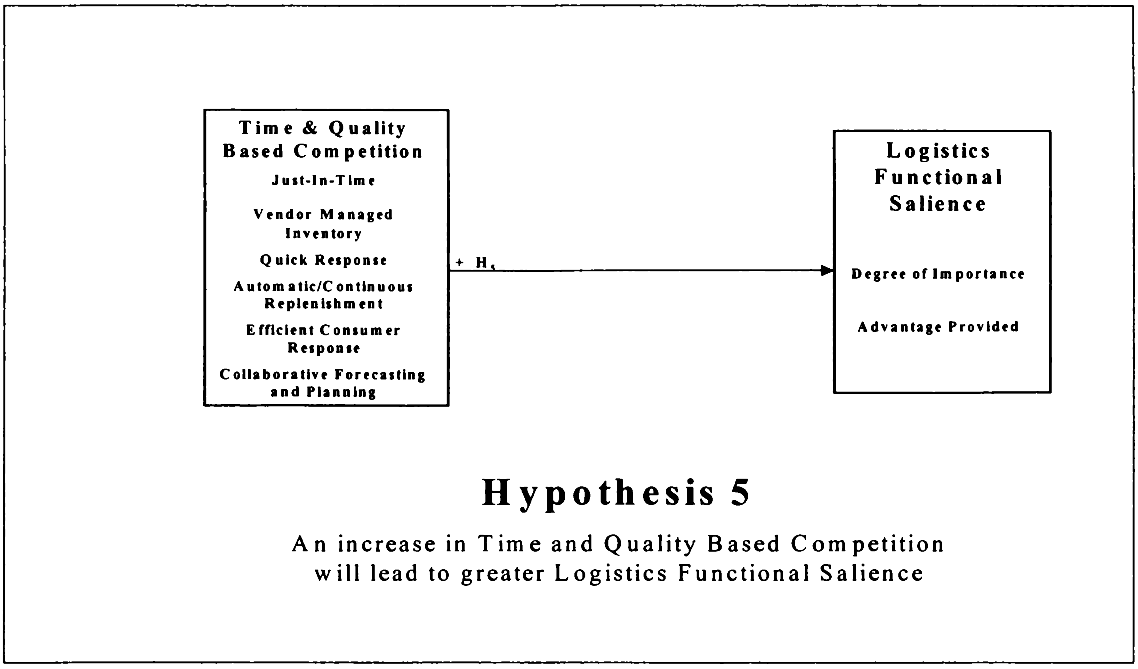

FIGURE 2.11 Time and Quality Based Competition and Logistics Functional Salience

firms are forced to compete based on quality products, consistent product availability, and faster product delivery to meet customer demand. Logistics as a function has an important role to play in time and quality based competition where consistent product availability and fast product delivery becomes more critical.

In this dissertation six time and quality based competition strategies were identified. Mentzer (1998) identified four specific strategies that are used in time and quality based competition, just-in-time (JIT), quick response (QR), vendor managed inventory (VMI) and continuous replenishment programs (CRP).

Just-in-time (JIT) in manufacturing is the concept that parts are only produced at each step to supply the immediate demand of the next step. JIT also suggests that parts are supplied as they are needed in very specific time frames to reduce the need for inventory. Quick Response (QR), Vendor managed Inventory (VMI), and Continuous Replenishment Programs (CRP) are very similar to JIT but they deal with the distribution of finished products from manufacturers and wholesaler to retailer (Larsen and Lusch 1990). Quick Response (QR), Efficient Consumer Response (ECR), Vendor Managed Inventory (VMI), and Automatic Replenishment (AR) all focus on rapidly replenishing inventory based on real time sales data. QR is implemented by monitoring retail sales using POS data and sharing that information across the supply chain. Continuous information exchange reduces uncertainty in the total supply chain and creates the opportunity for reduced inventory and improved availability. ECR originated in the grocery industry, where the focus is on a consumer-driven system in which members of a supply chain work together, and is dependent on timely, accurate, paperless information flow. One ECR study, sponsored by the Food Marketing Institute, estimated 42 days could be removed from the typical grocery supply chain, freeing up $30 billion in current costs, and reducing inventories by 41 percent (Sengupta and Turnbull 1996).

VMI is a modification of QR in that the vendor does not have to wait for the replenishment order, but assumes responsibility for directly replenishing the retail inventory. The goal of VMI again focuses on having a flexible supply chain that is updated continuously with real time sales information. Automatic Replenishment

(AR) extends QR and VMI by giving suppliers the right to anticipate future requirements and replenishing accordingly (Bowersox and Closs 1996).

Collaborative, Planning, Forecasting and Replenishment (CPFR) is found primarily in the food and consumer products industry. CPFR can be defined as transferring end-customer information as far up the supply chain as possible to plan upstream supply chain activities such as distribution and production scheduling (Bowersox, Closs and Stank 1999). The goal is to synchronize the supply side with the demand side of the supply chain while lowering total supply chain inventories.

The first three measures associated with the construct of Time and Quality Based Competition of Just-In-Time, Vendor Managed Inventory and Quick Response was obtained from Mentzer (1999). The measure of Automatic Replenishment was obtained from Ellinger, Taylor and Daugherty (1999). The last two measures of efficient consumer response and collaborative planning forecasting replenishment were obtained from the interviews.

HYPOTHESIS 6

Hypothesis 6 stated an increase in global factors would lead to greater logistics functional salience, as can be seen in Figure 2.12.

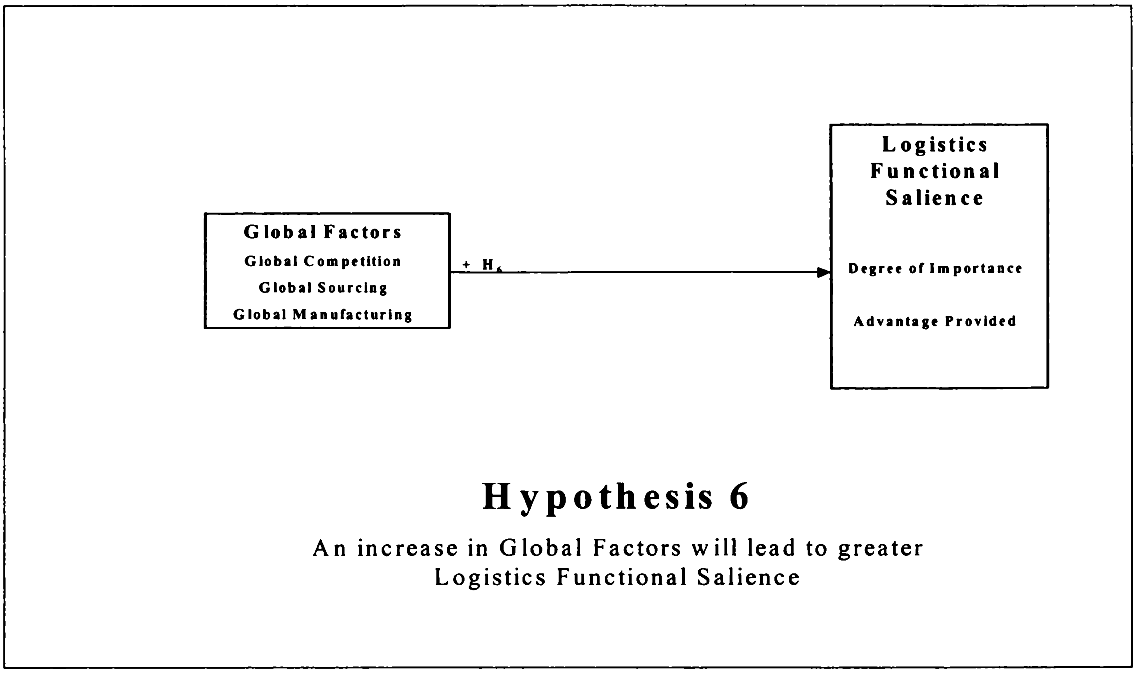

FIGURE 2.12 Global Factors and Logistics Functional Salience

Global Factors

Another factor affecting the competitive environment faced by companies is the increasing globalization of the world economy. There has been an increase in global competition as companies seek to lower manufacturing costs and find new markets for their products. Improvements in transportation and information technology coupled with decreasing tariffs have led to the concept of world wide markets for products and services. Logistics within the firm has an important role in managing international suppliers and international customers. The three measures for this construct are global sourcing, global competition and global manufacturing which were obtained from the interviews.

HYPOTHESIS 7

Hypothesis 7 stated an increase in logistics functional salience will lead to greater logistics involvement, as can be seen by Figure 2.13.

Logistics Involvement

Logistics involvement (LI) is also a second order construct like logistics functional salience. This dissertation hypothesized that logistics involvement in the new product process will be of benefit to NPD project performance and logistics performance. Therefore, LI represents the timing, the degree and influence that logistics has on the NPD process. LI will be determined based on when logistics got involved, the level of resources committed, the influence logistics exercises and the type of involvement on the NPD process.

The first dimension is timing which is concerned at with percent of completion or exactly when logistics first becomes involved in new product development. Since this research is exploratory, it was felt identifying which of the five stages of pre-launch or at what percent of completion is most appropriate for early logistics involvement is beyond the scope of this dissertation and is more suitable for future research. Therefore, any logistics involvement before 100% completion is considered early logistics involvement (ELI) for the purposes of this dissertation. Timing is a single item construct and is only used to categorize which firms had logistics involved in new product development before product launch.

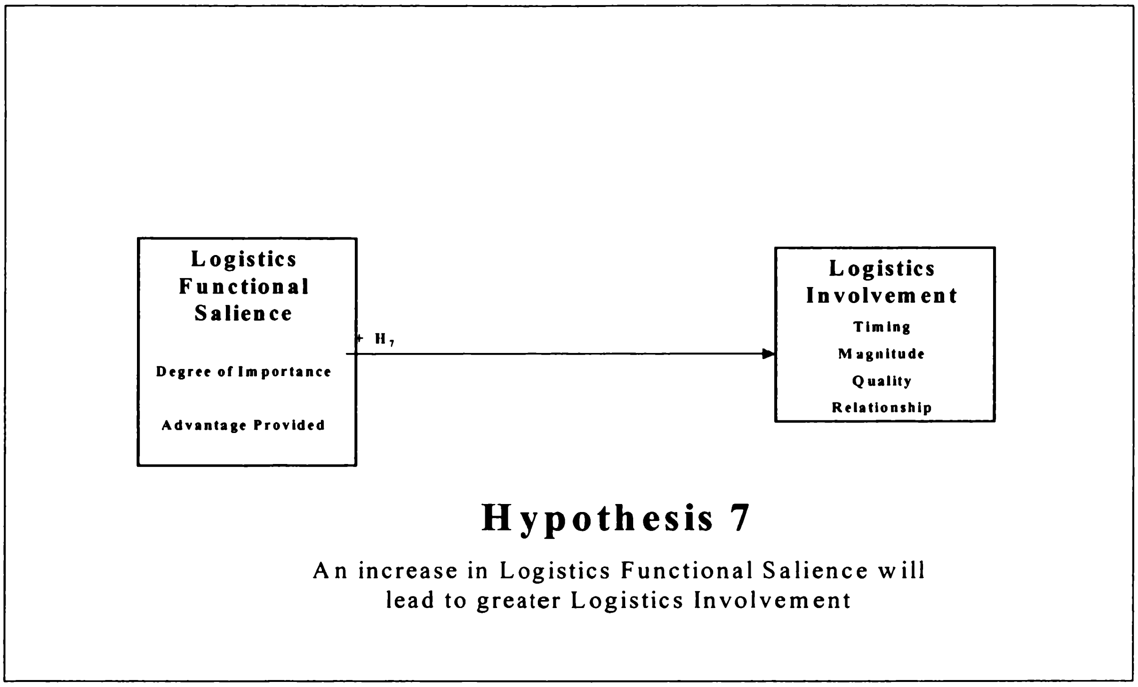

FIGURE 2.13 Logistics Functional Salience and Logistics Involvement

The remaining three dimensions magnitude, quality, and relationship and their respective measures are adapted from Birou (1994) for supplier involvement. The first two dimensions – magnitude and quality - are designed to measure the extent of involvement that logistics has with the NPD team. With magnitude, logistics survey respondents who were involved in new product development prior to launch were asked to state the amount of involvement in the five steps of product development and launch. Quality specifically asks the respondents to state in qualitative terms how valuable was the logistics involvement in terms of creativity, independent/unique ideas, number of ideas presented and number of ideas implemented. The last dimension - relationship - is designed to capture the type of involvement that logistics has in the process. How committed, cooperative and valued were the logistics members of the product team? The logistics involvement construct with the respective measures for Timing, Magnitude, Quality and Relationship can be seen in Figure 2.14.

HYPOTHESIS 8

Hypothesis 8 stated the greater the innovation level the greater the logistics involvement, as can be seen by Figure 2.15.

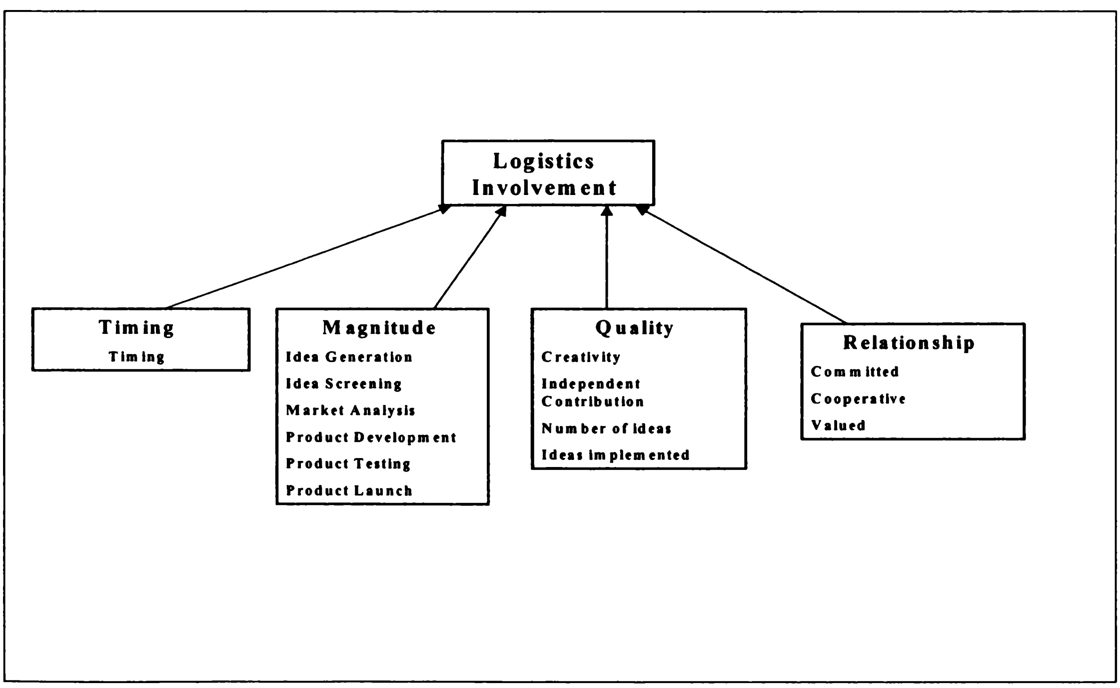

FIGURE 2.14 Indicator Constructs Within Logistics Involvement

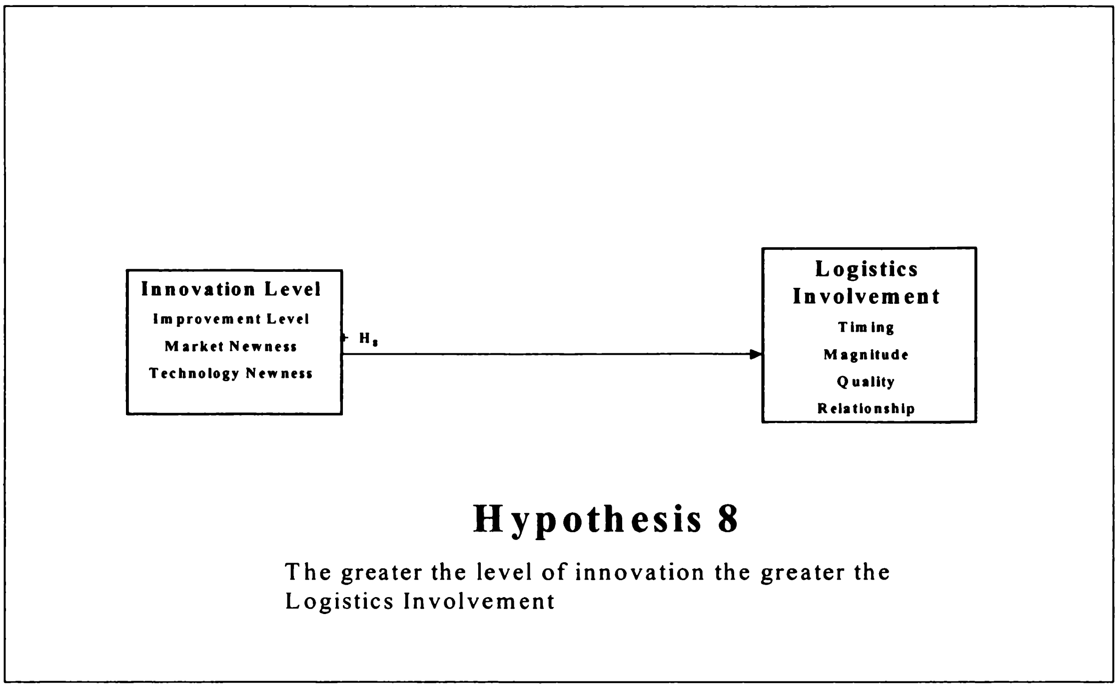

FIGURE 2.15 Innovation Level and Logistics Involvement

HYPOTHESIS 9

Hypothesis 9 stated the greater the cross-functional integration the greater the logistics involvement, as can be seen by Figure 2.16.

The next three hypotheses related cross-functional integration and logistics involvement to project performance and logistics performance. This is the output portion of the overall model.

HYPOTHESIS 10

Hypothesis 10 stated the greater the level of cross-functional integration the greater the level of NPD project performance, as can be seen by Figure 2.17.

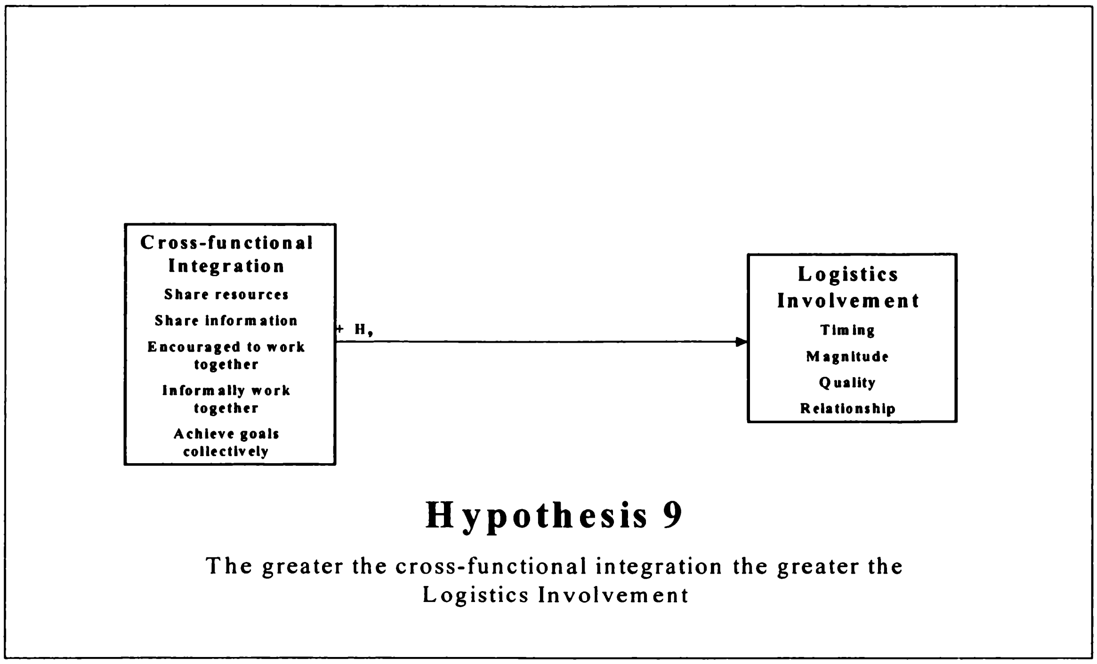

FIGURE 2.16 Cross-Functional Integration and Logistics Involvement

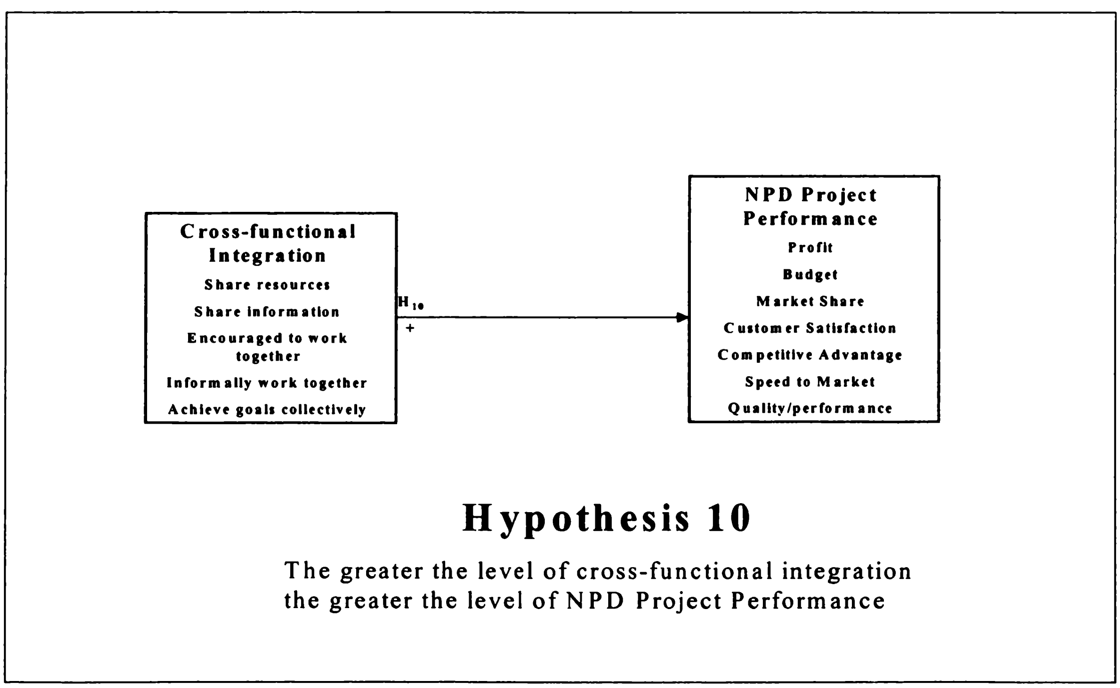

FIGURE 2.17 Cross-Functional Integration and New Product Development Project Performance

NPD Project Performance

NPD Project performance has the following seven measures: Profit, Budget, Market Share, Customer Satisfaction, Competitive Advantage, Speed to Market and Quality/performance. Profit and Budget are fundamental and overall measures that reflect the value of a NPD project. These two measures were adapted from Rochford and Rudelius's (1992) survey on new product development. Customer Satisfaction and Competitive Advantage was identified during the expert interviews as an important measure of NPD project performance. Market Share, Speed to Market and Quality/performance were adapted from Griffin and Hauser's (1996) survey for new product development.

HYPOTHESIS 11

Hypothesis 11 stated the greater the level of logistics involvement the greater the level of NPD project performance, as can be seen by Figure 2.18.

HYPOTHESIS 12

Hypothesis 12 stated the greater the level of logistics involvement the greater the level of logistics performance, as can be seen by Figure 2.19.

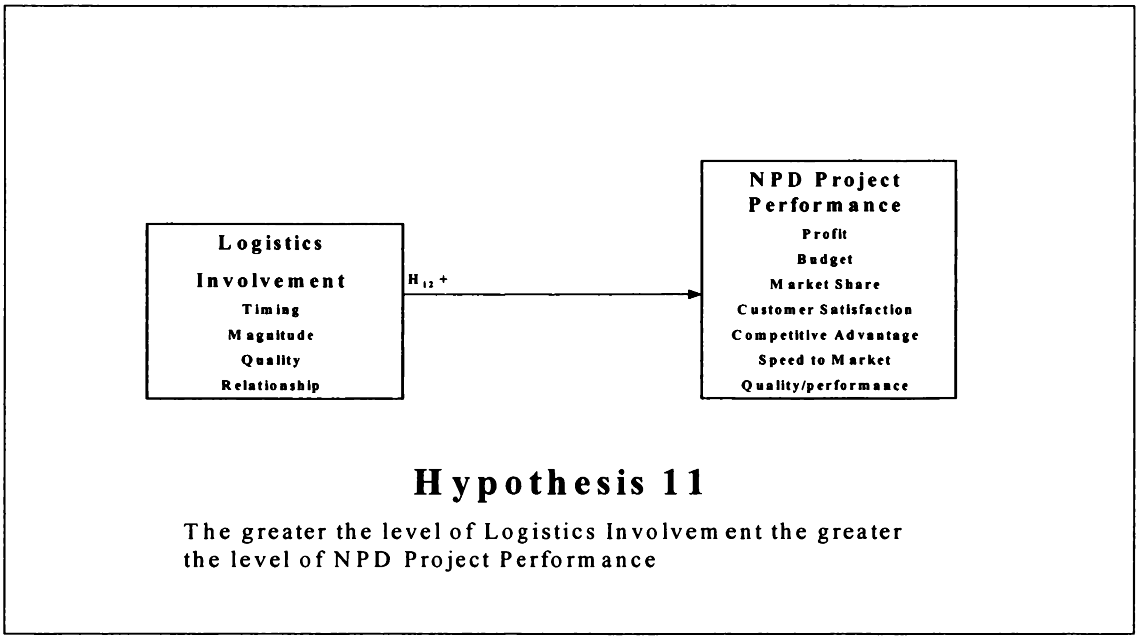

FIGURE 2.18 Logistics Involvement in New Product Development Project Performance

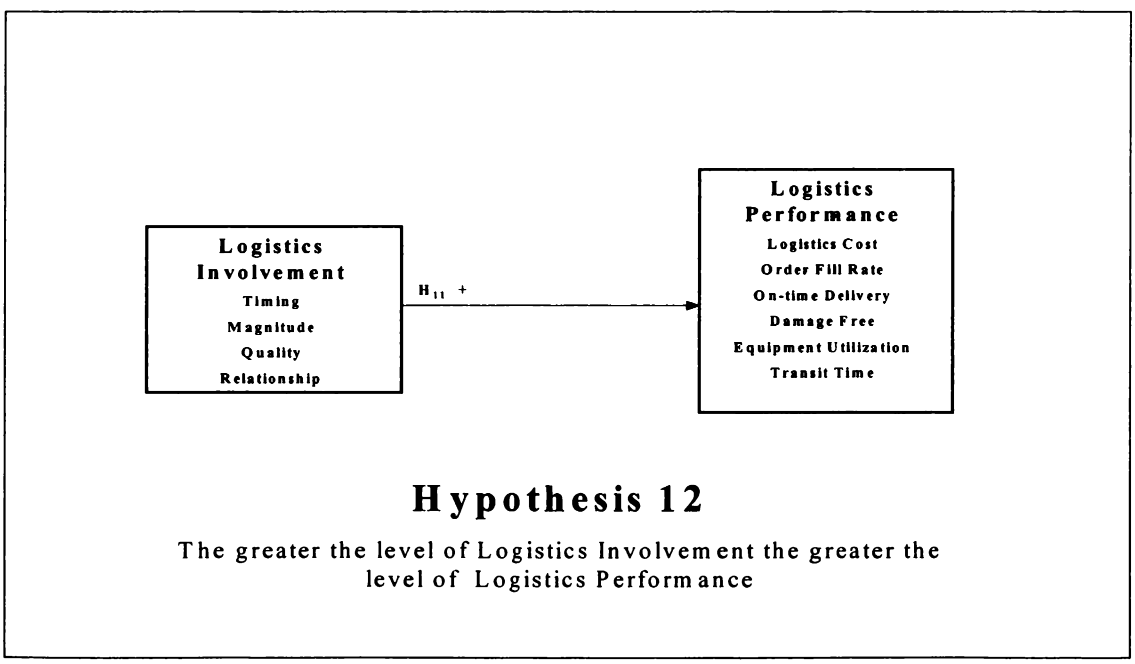

FIGURE 2.19 Logistics Involvement and Logistics Performance

Logistics Performance

In addition to improving project performance by having earlier logistics involvement it is also suggested that logistics performance for the new product would improve with earlier logistics involvement. In other words having direct logistics involvement would lead to designs that facilitated logistics performance. Interestingly, it might also be possible to suggest that Cross-Functional integration would lead to greater logistics performance but since CFI can be any two functions and not necessarily reflect logistics involvement there is less likelihood that greater CFI would lead to improved logistics performance. Therefore the relationship between CFI and logistics performance was not tested.

Logistics performance variables, according to Chow, Heaver, and Henriksson (1994), are the following three factors: logistics cost, order fill rate and on-time delivery. The next three measures: damage free, equipment utilization and transit time, were obtained from the expert interviews.

The hypotheses tested in the model are summarized below in the order they were presented:

H_1: *Companies that face an increase in environmental uncertainty will tend to produce higher levels of innovation level products.*

H_2: *Logistics functions in companies that face an increase in environmental uncertainty will become more salient.*

H_3: *Companies that face an increase in environmental uncertainty will encourage greater cross-functional integration during new product development.*

H_4: *Logistics functions in companies that undertake improvements in information technology will become more salient.*

H_5: *Logistics functions in companies that face an increase in time and quality based competition will become more salient.*

H_6: *Logistics functions in companies that face an increase in global factors will become more salient.*

H_7: *Companies that use logistics for a competitive advantage or where the logistics functional is salient will have greater logistics involvement in new product development.*

H_8: *Companies that are developing highly innovative products will have greater logistic involvement.*

H_9: *Companies that have higher levels of cross-functional integration will have higher levels of logistics involvement.*

H_{10}: *Companies that have higher levels of cross-functional integration will have greater new product performance.*

H_{11}: *Companies that have higher levels of logistics involvement will have greater logistics performance.*

H_{12}: *Companies that have higher the levels of logistics involvement will have greater new product performance.*

SUMMARY

This chapter began with a brief review of contingency theory and how it leads to the concept of logistics functional salience. New product development literature was reviewed and an historical view of cross-functional integration, from R&D and marketing working together, to R&D, marketing and manufacturing working concurrently, was provided. This led to the idea that the environment is rapidly changing and becoming more uncertain, information technology is improving, time and quality based competition is increasing and the market place is becoming increasingly global. This changing external environment is leading to the role of logistics within the firm becoming more important - logistics functional salience. This rise in the importance of logistics within the firm would make it beneficial to have logistics involvement in the new product process as part of a cross-functional team before product launch. This literature review and expert interviews led to the development of an overall model, Figure 2.5 – Logistics Involvement in New Product Development. In the next chapter, the research design and methodology used to test this model are discussed.

CHAPTER 3

RESEARCH METHODOLOGY

In this chapter the research design, including the unit of analysis, construction of the survey instruments, description of the sample population, data collection procedures and variable measures that were used in this dissertation, is discussed.

RESEARCH DESIGN

A survey research design was used to collect data to test the hypotheses developed in Chapter 2. A survey research design was considered appropriate for this dissertation because: (1) surveys can easily collect data from a large cross-industry population; (2) data gathered by surveys are easily quantifiable and amenable to statistical analysis and hypothesis testing; (3) and information obtained by survey is relatively accurate within sampling error (Kerlinger 1992). The surveys were developed and administered following Dillman's (1978) total design method approach. Multi-item measures were developed or adapted to more accurately evaluate the constructs that are proposed (Churchill 1979; Gerbing and Anderson 1988).

Initially the constructs and their variables as proposed in this dissertation were presented to logistics practitioners, new product development managers and academics separately to determine if the constructs capture logistics involvement in

NPD. These sessions were used to develop a survey that was suitable to send to logistics managers.

There are three important reasons to select senior logistics managers as the respondents for this dissertation research. First, senior logistics managers should be familiar with the role of logistics as a function within the firm in terms of logistics functional salience. Second, logistics managers should be familiar with the role logistics currently plays in new product development or logistics involvement in the firm. Third, logistics managers should be familiar with logistics performance variables used in this research.

Many of the constructs in this dissertation have been adapted from the new product literature so the most important question initially was to determine if the constructs are valid in this substantive new context.

All the variables of interest were estimated through logistics managers' perceptual evaluation of logistics involvement, NPD project performance, logistics performance and innovation level . Specifically, each respondent was asked to rate each item on a 7-point scale. The advantages of a Likert scale included (1) flexibility in terms of word and sentence lengths and vocabulary complexity, (2) economy in terms of common instructions for multiple items, (3) ease and quickness in completing a survey, (3) ease of composition, and (4) the ability to obtain a summated value as well as individual values of each item to measure a more general construct (Alreck and Settle 1995).

To increase the likelihood of responding to the surveys, very few quantitative or objective measures were included. Quantitative or "hard data" are difficult to get, especially with new product development projects that tend to be considered highly proprietary or confidential. In this type of research, there is greater value in being able to gather data from as wide a range as possible. The surveys, in addition to questions about logistics and NPD, also contain control variables such as the size of the firm in broad terms such as annual sales, percentage of revenue from new products and the competitive nature of the industry.

To develop the surveys, many of the measurement items associated with new product development were adapted from the literature. Items relating logistics involvement in new product development had not yet been developed, which required the following process as suggested by several researchers (Churchill 1979; Dunn, Seaker, and Waller 1994; Bienstock, Mentzer, and Bird 1997) be used: (1) item generation through the literature review and experience survey interviews with industry experts, (2) academic expert review, (3) debriefing with industry experts, (4) pretest with managers, and (5) item purification in the main study. Note the process of item development and refinement was iterative and built on each step of the process.

The first step of this process was to generate a large pool of items for the logistics involvement constructs through the literature review as well as the experience survey with industry experts (Bienstock, Mentzer, and Bird 1997). Twenty-one in-depth interviews that lasted approximately ½ hour were conducted with company executives representing the automotive, rail transportation, retail manufacturer, logistics, truck transportation, telecommunications, internet, returnable packaging and chemical industries. Some of these companies provided access to both the logistics manager and the new product manager so that two different perspectives on the new product process were obtained. A list of the companies that were interviewed can be found in Appendix I.

The second step was to develop a cover letter and the survey for logistics managers from the literature review and experience interviews as discussed above (Bienstock, Mentzer, and Bird 1997). Academic experts were asked to evaluate measurement items and drafts of the survey from the standpoint of representativeness, item specificity, clarity of construction, readability, content validity and face validity. Content validity assesses whether (1) the items are consistent with the theoretical domain of the construct; (2) the items are representative of the constructs the items are proposed to measure; and (3) the items are not difficult, ambiguous, or double-barreled statements. Face validity simply means the constructs, by the review of the experts in that research area, seem to measure what they purport to measure. The difference between content validity and face validity is content validity requires a more formal procedure to test. The content validity and face validity tests, however, were not solely dependent upon the reviews made by academic experts. Instead, the tests were iterated in the process of the measurement item development and purification. Based upon the reviews by academic experts, some of the measurement items were eliminated and reworded, and others were added.

The third step involved having the interview participants and academic experts review and give comments on the latest version of the survey. This was the readability survey to ensure the instructions were clear on the survey and the questions were answerable. A copy of the readability survey can be found in Appendix I.

This stage is called "debriefing" in which the content validity and face validity were tested on a continuing basis (Bienstock, Mentzer, and Bird 1997). At the debriefing stage, the items were again tested for clarity and appropriateness with the participating logistics managers. Logistics managers were asked to complete the readability survey, verify any ambiguity or other difficulties they experience in responding to the items, and offer any suggestions to improve the questionnaire. Based upon the feedback received, some items were again rewritten or eliminated, and others were added.

The three main sources of information that were used to develop the survey included literature from new products and logistics, industry executives and academic experts. A complete listing of the sources used for each measure and item can be found in Appendix I.

UNIT OF ANALYSIS

The unit of analysis in this dissertation was a completed new product development project that had a product in the marketplace. The ideal respondents for the survey were senior level logistics managers who were asked to identify a completed project that had been launched into the marketplace. Since product performance is an important outcome variable, it was important that the product was in the marketplace. Using a single project as the unit of analysis fits with much of the research found in new product development according to recent meta-analyses on product innovation (Montoya-Weiss and Calantone 1994, Brown and Eisenhardt 1995, and Kessler and Chakrabarti 1996). Another advantage of using the project as the unit of analysis was that specific practices and their influence on project success tend to be more readily identifiable than using the firm as the unit of analysis. This also made it easier to compare the results of this research to other NPD research that used the same unit level of analysis.

PRE-TEST

The fourth step involved pre-testing the survey with a sample of firms that was identical to the same sampling frame as the final test. It was decided to use the membership list from the Council of Logistics Management, specifically those that had chosen manufacturing as their primary business. This sampling frame automatically includes companies where logistics exists as a separate function, as they are members of CLM, and by selecting manufacturing related companies there would be a greater likelihood that these companies would have experience developing new products.

A 4-page survey with the items designed to measure the constructs as described earlier was developed. To summarize there were 10 latent constructs as can be seen in Table 3.1.

There were two 2^{nd} order constructs, Logistics Functional Salience and Logistics Involvement as can be seen in Table 3.2.

The entire model with the hypotheses and all the constructs can be seen in Figure 3.1.

The purpose of this pre-test was to ensure the items loaded on the constructs as intended. The pretest questionnaire included the measurement items that were generated and revised in the previous stages. In this stage, item-total correlation was measured to delete redundant items: any item that showed low item-total correlations was considered for deletion (Bienstock, Mentzer, and Bird 1997). The deletion decision used a qualitative assessment, which was based upon the results of the content and face validity tests through the literature review, experience survey/interviews, and academic expert review (Bienstock, Mentzer, and Bird 1997).

A copy of the pre-test survey can be found in Appendix II.

TABLE 3.1 First Order Constructs

Constructs	Items
Innovation Level	3
Product Performance	7
Cross-Functional Integration	5
Involvement Magnitude	6
Involvement Quality	6
Involvement Relationship	3
Logistics Performance	6
Degree of Importance	4
Advantage Provided	4
Environmental Uncertainty	5
Time and Quality Based Competition	6
Global Competition	3
Improving Information Technology	7

TABLE 3.2 Second Order Constructs

Latent Variables	Indicator Constructs	Items
Logistics Functional Salience	Degree of Importance	4
	Advantage provided	4
Logistics Involvement	Timing	1
	Magnitude	6
	Quality	4
	Relationship	3

For the pre-test, it was decided to try 3 different methods of contacting potential participants: mail, e-mail and phone. The cover letters associated with mail, e-mail and phone can be seen in Appendix II. To facilitate e-mail participation, an on-line version of the survey was developed. Two reminder e-mail notices were sent after the initial e-mail, one week and 3 weeks respectively.

The original list of CLM members who had indicated manufacturing was 2039. Out of this group a random sample of 406 potential participants were identified for the pre-test. Eighty-two participants were contacted by mail. One hundred twelve participants were contacted by phone. Two hundred twelve participants were contacted by e-mail. Initially, it had been decided to contact an equal number via phone and e-mail but unfortunately it was difficult to contact people via phone as many people were not there and we had to resort to leaving

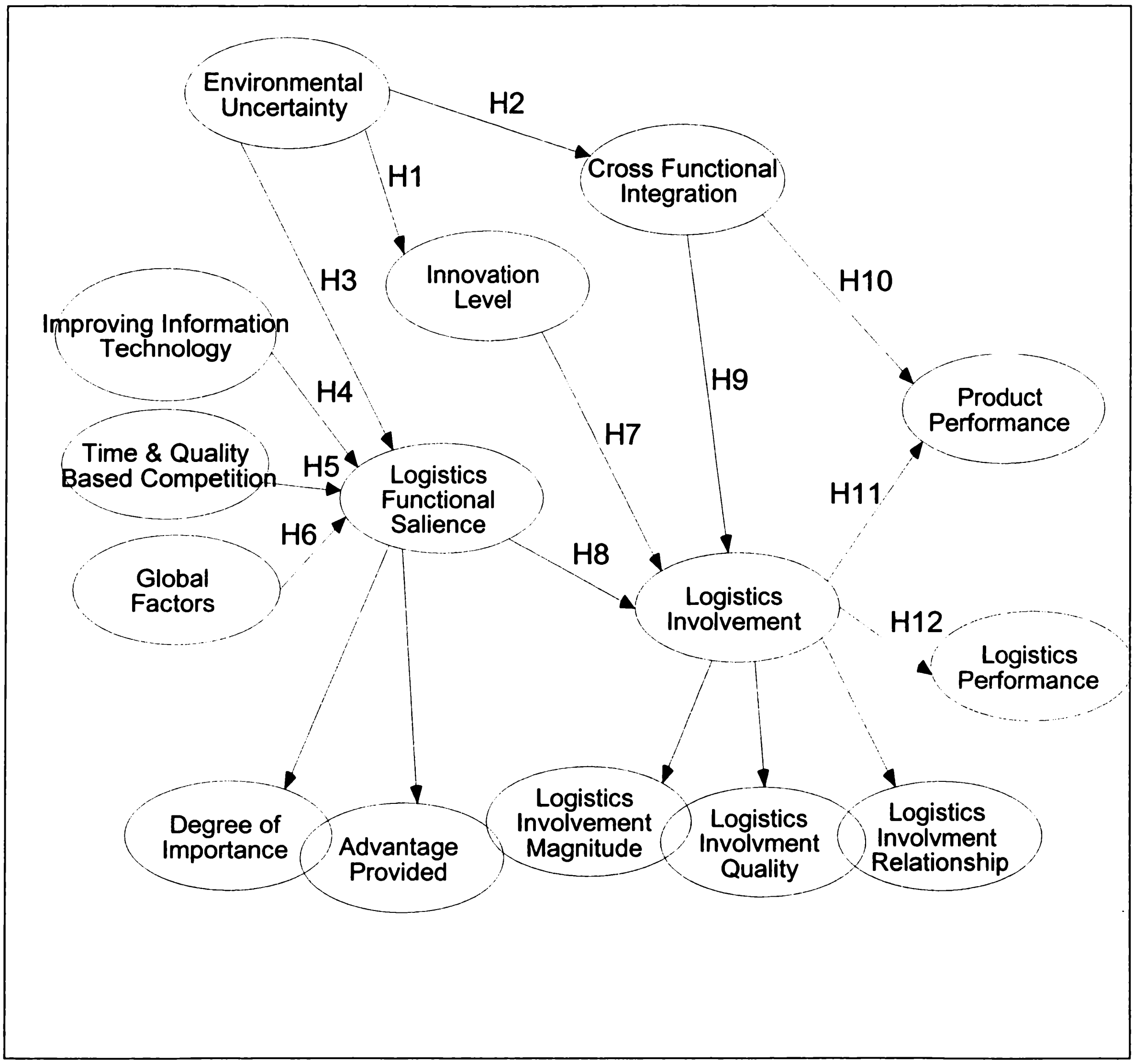

FIGURE 3.1 Logistics Functional Salience and Involvement in New Product Development

messages, etc. Therefore, after we were unable to contact people via phone, we decided to add them to the e-mail list which led to an increase in the number being contacted by e-mail. Dillman's (1978) protocol of three reminder notices was utilized for the e-mail and there was an increase in the number of respondents after each reminder. Sixty-five respondents indicated they were prohibited, or not willing, to do the survey which left a sample size of 341. One response was unusable because the respondent had only faxed three pages which meant over a third of the questions were missing which left 50 responses out of a choice of 75 items. Therefore, the effective response rate was 14.2%.

DESCRIPTIVE STATISTICS

The descriptive statistics for the pretest data are given in Appendix 3. Mean, minimum and maximum values, standard deviation, kurtosis and skewness for each item were examined for unusual irregularity. The values for mean and standard deviation were quite acceptable.

Non-response or missing data are an important problem and the data were first reviewed to determine if there were any patterns in the missing data. Approximately 1/3 of the questions had no missing responses. Most of the remaining items had a single missing response (2%) and no real pattern was discernable. There are four items that had more than 2 missing responses - CFPR

(5 missing -10%), market share (4 missing- 8%), budget (3 missing – 6%), and APS (3 missing 6%). Upon further review it was noted that CFPR had two of the letters transposed. In other words, the item should have been written as CPFR for Collaborative Planning Forecasting and Replenishment not CFPR. Market share might be unknown but it is a valuable item and it was decided to keep market share in the survey as is. Budget seems to be a sensitive topic and it was felt having 3 respondents skip the item was not severe enough to warrant any changes. APS, which is an acronym for Advance Planning and Scheduling, was probably not familiar to some of the respondents but it was again decided that having only 3 respondents skip the item was not enough to warrant any changes.

Next, the data were reviewed for skewness and kurtosis. This can be important because structural equation modeling (SEM) is said to be sensitive to highly kurtotic variables; therefore, reliable parameter estimates and model fit might not be obtained, especially under maximum likelihood estimation method (West, Finch and Curran 1995). This is contrasted by some other authors who suggest that overall the maximum likelihood method in structural equation modeling is quite robust against violation of normality (Chou and Bentler 1995).

A rule of thumb to test if the data are highly skewed is to consider variables that have absolute values greater than 1 as skewed. The following variables were found to be skewed, with absolute skew values greater than 1.0: customer satisfaction, launch, idea generation, idea screening, market analysis, product development, service quality advantage, importance, visibility and access.

A rule of thumb to test if the data are highly kurtotic is to consider variables that have absolute values greater than 1.0 as kurtotic. The following variables were found to be kurtotic, with absolute kurtosis values greater than 1.0: speed to market, quality, idea generation, idea screening, testing, independent contribution, impacted, committed, cooperative, highly valued, market analysis, service quality advantage and global sourcing.

Even though some of the variables could be considered skewed or kurtotic, it was decided not to remove these variables prematurely as these violations of normality would not be problematic in SEM and could be the result of having only 50 respondents in the pre-test.

SCALE PURIFICATION

The scale purification process attempts to ensure the scales that are developed are unidimensional and the scales are reliable. This section provides a brief description for each component of the scale purification process, how each component was assessed within this dissertation, and the results of that assessment.

A scale is considered unidimensional when the items of the scale estimate one factor. Factor analysis was used to evaluate the scale's unidimensionality to determine if the items loaded on the hypothesized construct. Using the pre-test sample of 50, each of the items loaded as hypothesized. There were 13 constructs and they were assumed to be unidimensional because each of the multi-item scales that became part of the final test contained item to factor loadings of at least .5 with most items loading at .75 or greater. The detailed item-to-factor loadings are found in Appendix II.

Once unidimensionality was established, scale reliability was assessed for all 13 constructs. Using Cronbach's coefficient alpha (Cronbach 1951) reliability was assessed for the 8 first order constructs as seen in Table 3.3.

There were two second order constructs, Logistics Functional Salience and Logistics Involvement, that were made up of six first order (indicator) constructs, and their Cronbach's alpha can be seen in Table 3.4. Further detail on the reliability analysis that includes item statistics, item-to-item correlations, scales statistics, item-to-total statistics and reliability coefficients can be found in Appendix II.

SAMPLE

As discussed in the research design section, this research employed a non-experimental survey technique. The two primary limitations of mail surveys are the potential incidence of non-response and false reporting biases but the benefits of being able to reach a large sample size in a short time period at a lower cost makes the mail survey the technique of choice. This section provides a discussion of final

Table 3.3 First Order Constructs Reliability

1st Order Construct	Cronbach's Coefficient Alpha
Innovation Level	.566
Environment Uncertainty	.778
E-Commerce	.807
Improving Information Technology	.860
Time & Quality Based Competition	.890
Global Factors	.843
Cross-functional Integration	.925
NPD Logistics Performance	.835
NPP Project Performance	.869

Table 3.4 Indicator Construct Reliability

2nd Order Constructs	Indicator Construct	Cronbach's Alpha
Logistics Functional Salience	Degree of Importance	.947
	Advantage Provided	.920
Logistics Involvement	Timing	------
	Involvement Magnitude	.856
	Involvement Quality	.890
	Involvement Relationship	.942

test sampling issues that includes (1) limitations (2) sample characteristics and (3) implementation.

LIMITATIONS

Kerlinger (1986) identifies the two limitations of mail survey research are non-response bias and inability to check responses. To handle non-response bias, it was decided to examine the differences between waves of survey response as proposed by Armstrong and Overton (1977). In addition, the method recommended by Mentzer and Flint (1997) of examining the differences between actual survey respondents and non-respondents was employed. A random sample of 34 non-respondents was e-mailed and asked 6 questions about the dependent or outcome variable. The results of these techniques are discussed in Chapter 4.

Presently there is no easy way to check response accuracy and that is a limitation with this type of research. No attempt was made to adjust for or validate actual responses.

CHANGES MADE BECAUSE OF PRE-TEST

There were two major changes made as a result of the pre-test. The first change was to convert CFPR in question 15(f) to what it should have been before the typo, and that is, CPFR.

The second change considers the method of contact as found in Table 3.5.

Table 3.5 Method of Contact in Pre-test

Method of Contact	Number Contacted	Responded	Unable to Participate	Response Rate (%)
Mail	82	2	0	2.4
Phone	112	20	16	20.8
E-mail	212	28	49	17.2

Even though calling on the phone seemed to be the best method on paper in terms of response rate, we found that a lot more time had to be spent in this process as many people were out of the office and it took many attempts to reach a single person. When one was able to actually talk to the person directly, there was a high chance that they would be willing to look at the survey. Unfortunately, getting to the actual person was rare which made this method of survey impractical.

Therefore, since E-mail was much quicker and the online response allowed the task to be fairly easy and since the response rate was comparable it was decided to use E-mail as the primary method of contact.

CLASSIFICATION QUESTIONS

Several classification questions about the respondent's business unit and the respondent were asked (Appendix III, Final Survey, Section 5 – Respondent/Firm Description). These questions include the respondent's title, department, experience with new product projects, primary industry where firm competes, percent of profits from products less than five years old, approximate age of the company, approximate number of employees world wide, and annual sales worldwide.

THE FINAL QUESTIONNAIRE

Following the pre-test evaluation, the final survey was developed (Appendix III). There are five sections in the survey.

Section 1 - New Product Project Description focused on the specific project that will evaluated in the survey. The first question in the survey asked them how many years the product had been in the marketplace so that respondents immediately knew that they should be thinking about a product that is already in the marketplace as opposed to something still in development. The constructs in this section included innovation level, product performance and cross-functional integration.

Section 2 – Logistics Involvement focused on the early involvement of logistics in new product development and an opportunity was provided to skip these questions for those respondents where logistics was not involved before product launch. The constructs in this section included the 2^{nd} order construct of Logistics involvement which is made up of Logistics Magnitude, Logistics Quality and Logistics Relationship.

Section 3 – Logistics/Distribution Description focused on the importance of logistics within the firm. The construct in this section is the second order construct Logistics Functional Salience and includes degree of importance and advantage provided.

Section 4 – Industry Description evaluated the environment that the company works in to look at the antecedents of logistics functional salience. The constructs in this section include environmental uncertainty, time and quality based competition and improving information technology.

Section 5 – Respondent/Firm Description had no constructs but instead asked demographic questions about the firm and the respondent to help categorize the response.

All the survey questions asked the respondent to make subjective judgments about the new product process and the role of logistics in that process. The use of subject measures is an accepted practice in the new product and logistics literature, supporting the high correlation between the respondent's subjective assessments and their objective counterparts (Narver and Slater 1990)

For most of the items, a seven-point Likert-type rating scale was used (e.g., 1 = Strongly Disagree, 7 = Strongly Agree; 1 = Not Used, 7 = Greatly Used. A seven-point scale instead of a five-point scale was used to provide a larger choice to improve the level of discrimination. It was decided not to have a "Don't know" answer choice because the focus of the survey was on the perception of a particular item, and not the "knowledge" about the item per se.

SAMPLING AND DATA GATHERING

The target firms were not limited to those in any single industry but open to firms in various industries in hopes of obtaining study results that were more generalizable across industries. The target respondents were senior-level logistics managers who are involved in overseeing logistics processes within the firm. The Council of Logistics Management (CLM) was contacted to obtain a list of members who had identified manufacturing as their area of interest. By using CLM members, it was possible to get senior level logistics participants, and using manufacturing as their base of interest, there was a greater likelihood that they had experience with new products.

PHYSICAL DESIGN AND LAYOUT

The methods suggested for conducting surveys by Salant and Dillman (1994) were followed as practically possible except e-mail was used instead of regular mail. As explained earlier, the primary method of contact was through e-mail so some of the aesthetic issues such as color of the paper did not come into consideration. Instead, e-mail is a medium that requires authenticity and quickly coming to the point. E-mail is designed for a quick response and succinctness is highly valued in this kind of message. It was felt that it was important to ensure the survey did not exceed 4 pages and not look too busy to encourage responses. The instructions were extensively tested to be as clear as possible. The subject line in the first wave of the e-mail stated Logistics and New Product Development with no mention of a survey to encourage respondents to open the e-mail. Response rates over thirty percent are rare and often only about five to ten percent respond to mail surveys (Alreck and Settle 1995). This e-mail survey exceeded that rate of five – ten percent return significantly. One problem associated with e-mail is reluctance on the part of recipients to open attachments from someone they do not know due to recent viruses that have been transmitted by unsolicited attachments. This directly reduces the response rate as some recipients would not open the e-mail message to determine if the survey was applicable. Unfortunately, it was not possible to estimate the percentage of non-respondents who did not open the e-mail message at all. In the bottom of the 4^{th} and final page, the respondents were thanked and a request for the respondent's business card was expressed. It represented the survey research's reciprocal nature – thanking them for the valuable information and promising them an executive summary report (a reward) – for those who were interested. To further enhance the response rate, respondents were given an opportunity to win one of 3 palm pilots in a drawing. Interestingly enough, 20 respondents, or 7% of the sample, chose to respond anonymously. Each respondent received 3 notices unless:

1) they responded to the survey.

2) they indicated their company did not allow surveys to be done.

3) the e-mail address was not valid.

4) they indicated the survey was not applicable.

After the initial survey was sent, a reminder e-mail with the survey attached was sent one week later. Two weeks later, or three weeks after the initial survey, a second reminder was sent asking for their participation. Two weeks after the three week mailing, or approximately five weeks after the initial survey was sent, a not applicable e-mail with the subject line indicating "Not Applicable" was sent encouraging the respondents to return the survey or indicate the survey was not applicable, again, to encourage a quick response. This resulted in a 36.8% response rate as will be described in the next chapter. If a survey packet was returned as undeliverable because of an error in the e-mail address, no replacement was done and they were removed from the sample. A copy of the three cover letters is included in Appendix III.

SCALE VALIDATION WITH THE FINAL SAMPLE

The scales that were used for the final sample were checked for unidimensionality and reliability prior to statistical hypothesis testing. The results are provided in the next chapter.

METHOD OF ANALYSIS

SEM was used as the main statistical analysis tool to test for a relationship:

- between Cross-Functional integration and logistics involvement
- between high logistics salience and logistics involvement in NPD
- between logistics involvement in NPD and project performance
- between logistics involvement in NPD and logistics performance
- between logistics involvement, innovation level and project performance
- between logistics involvement, innovation level and logistics performance

SEM is a powerful statistical technique that combines the measurement model (confirmatory factor analysis) and the structural model (regression or path analysis) into a simultaneous statistical test (Aaker and Bagozzi 1981, Garver and Mentzer 1999). SEM was used in this study because it provides a straightforward method of dealing with multiple relationships simultaneously and comprehensively while providing statistical efficiency. SEM also can account for measurement errors for both indicator and latent variables, resulting in less biased estimates for the structural parameters.

There are various indices of model adequacy. The three that were used in this dissertation are: (1) the chi-square goodness-of-fit test, which indicates the degree to which the model specified is consistent with the pattern of variances and covariances from the set of observed data, (2) the Bentler comparison fit index

(CFI), which allows the comparison of various equation models with a null or independence model of the constructs where no relationships among variables are specified, and (3) Root Mean Square Error of Approximation (RMSEA), which is the average difference per degree of freedom expected to occur in the population, not the sample.

The value for CFI should be above .9 to be considered acceptable to suggest a model is consistent with the observed data from which it was estimated. The value for RMSEA should be close to .05 to be considered acceptable (Hair, Anderson, Tatham, Black 1998).

A basic analyses of the returned surveys, including examination for incorrect coding, item normality, skewness, kurtosis, means, standard deviations, and outliers was performed (Mentzer, Flint, and Kent 1999). Initially, it was also necessary to check for response bias between early respondents and late respondents. Non-response error is defined as the variation between the true mean value of the variable in the original sample and the true mean value in the net sample (Malhotra 1993). Non-response error was tested by comparing early and late respondents for all of the constructs included in this study using ANOVA (Armstrong and Overton 1977). In addition, a random sample of 34 non-respondents was contacted directly to compare their responses on the dependent variable product performance with those from respondents to help verify evidence of non-response bias did not exist (Mentzer and Flint 1997).

As part of the analysis process of the returned surveys, it was necessary to assess unidimensionality, construct validity, nomological validity, face validity, and reliability to ensure the items are actually measuring what they were intended to measure (Mentzer and Flint 1997).

SUMMARY

In this chapter the research methodology that was used to test the research hypotheses was discussed. The hypotheses, the measures and the research design (basic research design, unit of analysis, sampling and data gathering, and statistical analyses for hypotheses testing) were also described.

CHAPTER 4

DATA ANALYSIS AND RESULTS

In this chapter, the analyses of the data and the results of the hypothesis testing are reported. First, descriptive statistics for the final sample are provided. The response rate, descriptive statistics and non-response bias are discussed. Reliability and construct validity are also examined for each construct based on the final sample data. This is followed by the results of the statistical analyses and hypothesis testing of the overall logistics involvement and new product development model.

FINAL SAMPLE DATA

Initially, a sample of 2041 names was provided by the Council of Logistics Management of those who attended the conference in 2000 and who had indicated manufacturing as their choice of affiliation. From this group a random sample of 268 members was contacted via e-mail, mail and telephone as part of the pre-test. This left a sample of 1773 that was selected as the final sample. Three hundred and twenty seven names were deleted because they had no e-mail address, which left a sample of 1430. Two hundred and twenty nine names were deleted as the e-mail messages bounced back with wrong e-mail addresses. Four hundred and thirteen respondents indicated the survey was not applicable. This left a final sample size of 804. Out of this group using a 4-wave mailing, 304 surveys were returned of which 8 surveys were deleted as they had missed answering 11 or more questions out of 67 or missed 16% of the survey. This left a final response of 296 usable surveys, used in the data analysis that is discussed in this chapter. The effective response rate was 36.8 percent, i.e. (296/(1773-327-229-413)).

DEMOGRAPHIC DATA

There were 7 questions used to determine the demographics of the sample population. The tables that summarize the demographic data can be seen in Appendix III.

Question 18 asked for the title of the survey respondent. A quick review of the titles indicated the majority were in management, with several at the executive management level.

Question 19 asked about the department to which the respondent belonged: 67% of the respondents indicated logistics; 21% indicated "other", usually choosing supply chain management; and 7% chose manufacturing.

Question 20 asked about the number of new products the respondent has been involved in. This question evoked the largest range of responses from 1 new product to several thousand. 72% of the respondents indicated from over 10 new products. This suggests most of the respondents are familiar with the process of developing several new products.

Question 21 asked about the primary industry in which the respondent was involved: 25% of the respondents indicated "other"; 18% chose computers/electronics; 18% chose food/beverages/tobacco; and 12% chose pharmaceuticals/health and beauty aids. This suggests a wide range of industries.

Question 22 asked about the percent of company's profits that come from products that were less than 5 years old. This was another question where there was a wide range of answers: 15 percent of the respondents stated 10% of the company's profits came from products less than 5 years old; 12 percent of the respondents stated 20% of the company's profit came from products less than 5 years old; and 5 percent of the respondents stated that 100% of the profits came from products less than 5 years old.

Question 23 asked about the age of the company: 90 percent of the respondents came from companies that were more than 16 years old. Therefore, the majority of the respondents came from companies that are well established.

Question 24 asked about the size of the company in terms of worldwide employees. Thirty two percent of the respondents belonged to companies that had between 10,000 to 50,000 employees, 25 percent belonged to companies with 1000 – 5000 employees, and 23 percent belonged to companies with over 50,000 employees.

Question 25 asked about worldwide annual sales. Forty three percent belonged to companies that did more than 6 Billion in sales, 28 percent were in companies that did between 1 - 5 Billion in sales.

DESCRIPTIVE STATISTICS

The descriptive statistics including variable descriptions for the final data are given in Appendix III. Mean, minimum, maximum values, standard deviation, kurtosis and skewness for each item were examined for any unusual irregularity. The mean values for most variables were reasonable except for the three early logistics involvement variables which were low, as can be seen in Table 4.1. This suggests, for a significant majority of the respondents, logistics was not involved initially in new product development. The standard deviation was approximately 1.3, which suggests the variability among the responses was acceptable.

The following variables were found to be skewed with absolute values greater than 1.0: LIM1, LIM2, LIM3, LIR2, AP2, IIT1. LIM1, LIM2, LIM3 were all negatively skewed in that the values were low for most of the respondents which suggests very low involvement early in the new product process. LIR2, AP2, IIT1 were positively skewed in that the values were high for most of the respondents which suggests that respondents feel they are highly cooperative in the new product team, that logistics provides high service quality advantage and EDI is greatly used in most companies. The following variables were kurtotic using an

Table 4.1 – Logistics Involvement Magnitude Variables

Variable	Description	Mean	Skew	Kurtosis
LIM1	Idea Generation	1.51	2.952	9.013
LIM2	Idea Screening	1.61	2.486	6.313
LIM3	Market Analysis	1.80	2.001	3.692

absolute value of 1.0: IT3, LIM1, LIM2, LIM3, LIQ4, LIQ6, AP2, EU2, EU3, TQBC5, GF1. Kurtosis measures the peakedness (positive values) or flatness (negative values) of the distribution. IT3, LIQ4, LIQ6, EU2, EU3, TQBC5 and GF1 had negative kurtosis, which suggests the distribution was flat and respondents seemed evenly distributed across the responses. LIM1, LIM2, LIM3, AP2 had positive kurtosis, which suggests a peaked distribution where the majority of respondents primarily picked a single response.

It was felt the skew and kurtosis of these items were not so severe that they had to be eliminated and so they were all included for further analysis.

NON-RESPONSE BIAS

Two non-response bias tests were performed on the final sample as outlined previously in Chapter 3. A one way ANOVA test was used to measure the differences in mean response between each of the 4 waves of the survey mailing for one of the two dependent or outcome variables. Product performance, or the variables PP1, PP2, PP3, PP4, PP5, PP6, were used to test if there was any bias between the different waves of responses. As can be seen in Table 4.2, there were no statistical differences between the waves for product performance at $P<0.05$.

Another way to test for non-response bias was proposed by Mentzer and Flint (1997) where a random sample of 34 non-respondents are contacted directly and asked five non demographic questions related to the hypothesis. This was done

TABLE 4.2

One-Way ANOVA Comparing Survey Mailing Waves For Non-Response Bias

Item	Description	Wave	N	Mean	Sig.
PP1	Profit	1.00	128	4.26	.329
		2.00	73	4.40	
		3.00	45	4.60	
		4.00	47	4.64	
PP2	Budget	1.00	128	4.17	.566
		2.00	73	4.32	
		3.00	45	4.47	
		4.00	47	4.26	
PP3	Market Share	1.00	128	4.30	.298
		2.00	73	4.44	
		3.00	45	4.53	
		4.00	47	4.77	
PP5	Competitive Advantage	1.00	128	4.84	.066
		2.00	73	4.84	
		3.00	45	5.31	
		4.00	47	5.19	
PP6	Speed to Market	1.00	128	4.74	.080
		2.00	73	4.97	
		3.00	45	5.20	
		4.00	47	5.17	
PP7	Quality/Performance	1.00	128	4.75	.098
		2.00	73	5.01	
		3.00	45	5.27	
		4.00	47	5.09	

for product performance and the results are summarized in Table 4.3. As can be seen there were no significant statistical differences between the respondents and non-respondents at $P<0.05$. Given these two tests, it was concluded that non-response bias was not a problem in the final sample.

SCALE VALIDATION

The first step in ensuring the scales are valid is to conduct confirmatory analysis to ensure each of the scales used in the survey is unidimensional. The 13 scales developed through the pre-test were tested using factor analysis and all were unidimensional. The results of this analysis can be seen in Appendix III. The lowest four item-to-factor loadings were: IL2 = .560, EU5 = .578., LP6=.645,

TABLE 4.3

One-Way ANOVA Comparing Respondent to Non-Respondent Bias

Question	Wave	Number	Mean	P Value
PP1	Respondent Non-Respondent	296 34	4.41 4.44	.492
PP2	Respondent Non-Respondent	296 34	4.23 4.32	.623
PP3	Respondent Non-Respondent	296 34	4.41 4.44	.621
PP5	Respondent Non-Respondent	296 34	4.98 5.03	.133
PP6	Respondent Non-Respondent	296 34	4.5 4.35	.641
PP7	Respondent Non-Respondent	296 34	4.92 5.15	.260

and LIM4 = .664. Most of the remaining 36 items loaded at .80 or greater. As can be seen, no single factor had more than one item that loaded below .7.

SCALE RELIABILITY

Scale reliability can be measured through Cronbach's coefficient alpha, as found in Table 4.4. Nunnally (1978) proposed Cronbach's alpha above .7 was acceptable for exploratory basic research. In this case Innovation Level was only .5502, which eliminated this construct from the final model. The remaining 12 constructs were used in the final Structural Equation Model.

CONFIRMATORY FACTOR ANALYSIS

Confirmatory analysis was conducted individually on the 12 constructs to ensure the items were unidimensional. The first step in confirmatory factor analysis is to ensure all the regression weights have P values significant to a pre-determined level. For this dissertation, P values below 0.05 were considered significant. In this first stage of checking for unidimensionality, the values for P were all below 0.01, which ensures the regressions are all significant. The following paragraphs look at each of the 12 constructs individually to ensure they are significant at the 0.01 level and should be included in the measurement model.

All five items for Environmental Certainty loaded onto the construct well; all 5 relationships were significant at the 0.0001 level. The χ^2 = 12.87, CFI =

Table 4.4 – Scale Reliability

Constructs	Cronbach's coefficient alpha
Innovation Level	.5502
Environmental Uncertainty	.7493
Improving Information Technology	.8226
Time and Quality Based Competition	.8299
Global Factors	.9128
Cross-Functional Integration	.9349
Degree of Importance	.9270
Advantage Provided	.8947
Logistics Involvement Magnitude	.8391
Logistics Involvement Quality	.9483
Logistics Involvement Relationship	.9404
Product Performance	.8868
Logistics Performance	.7040

.9764 and the Modification Indicies (MI) were below 5. These 5 items are all reverse coded, because in the survey higher numbers means greater certainty, which was changed to ensure that higher numbers meant greater uncertainty.

All seven items for Information technology had regression weights that were significant at the 0.0001 level. Item 2 and 3 for Information Technology had a MI of 42, which suggested high correlation between the two items. Item 2 asked whether the Internet is extensively used in your industry and Item 3 asked whether e-commerce is extensively used in your industry. Originally, it was felt that the Internet and e-commerce were different in that e-commerce suggests actual transactions are taking place on the Internet, but, clearly, in the minds of the survey respondents these two items are linked and so it was decided to combine them. This left 6 items for Improving Information Technology, with χ^2 = 37.87, CFI = .9422 and the largest MI =13.5.

All six items for Time and Quality Based Competition had regression weights significant at the 0.0001 level. Item 2 and 3 for Time and Quality Based Competition had a MI of 19.1. Originally, it was felt that Vendor Managed Inventory was distinct from Automatic Replenishment; however the respondents seemed to believe them very similar so it was decided to combine item 2 and 3. This left 5 items for Time and Quality Based Competition with χ^2 = 21.26, CFI = .9666 and the largest MI = 8.2.

Global Factors is a construct that has 3 items, which is the minimum for calculation of Cronbach's alpha but with structural equation modeling using AMOS 4.0 (Analysis of Moment Structures) software a three item construct was not enough. The number of equations equals the number of unknowns and therefore it is not possible to solve. This can be explained by using the global factor construct as an example in Figure 4.1.

In this case Global Factors has 10 parameters: the variances of Global Factor, e1, e2, e3, and the regression weights of global factor to GF1, GF2, GF3, and e1 to GF1, e2 to GF2, e3 to GF3. Four of these parameters are fixed at 1: the arrows between global factor and GF1 and each of the error regressions to GF1, GF2, GF3 as can be seen in Figure 4.1. With 4 parameters fixed there are 6 parameters free to vary and there are only 6 distinct sample moments, which means

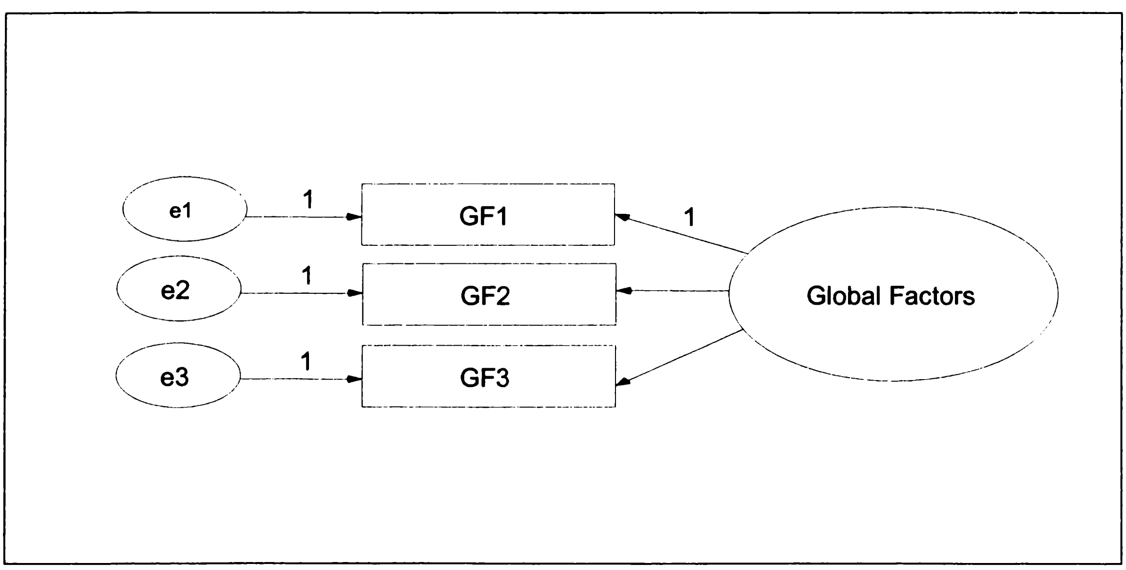

FIGURE 4.1 – Global Factors

DF = 0. In other words the number of known equations equals the number of unknowns and it is not solvable. Therefore, it is not possible to use AMOS 4.0 for confirmatory factor analysis in this instance as χ^2 = 0.0, DF = 0.0 and CFI = 1.0, which are quite unrealistic. Although it was not possible to test directly, it was decided to keep this three-item construct (Global Factors) in the measurement model as there would be additional degrees of freedom in the measurement model which allowed the construct to be properly analyzed. Cronbach's alpha for global factors was .9126, which is very acceptable, with the highest MI = 18.6. Therefore, Global Factors was included in the measurement model.

All five items for Cross-Functional Integration had regression weights significant at the 0.0001 level. The 5 items loaded onto Cross-Functional Integration with χ^2 = 32.9, CFI = .9782 and the largest MI = 13.2.

All four items for Degree of Importance had regression weights significant at the 0.0001 level. All 4 items loaded onto Degree of Importance as expected. The χ^2 = 33.8, CFI = .9764 and the highest MI = 17.58.

All four items for Advantage Provided had regression weights significant at the 0.0001 level. All 4 items loaded onto Advantage Provided. The highest MI was 19.8 but it was felt that item 1, a cost advantage, and item 4, a profitability advantage, were different and should not be combined in this case. The χ^2 = 32.45, CFI = .9570 and MI = 19.8.

Timing is a single item indicator construct for logistics involvement and was used as a categorical variable and not tested as part of the model.

There were six items for Logistics Involvement Magnitude that had regression weights significant at the 0.0001 level. Interestingly enough, item 6 had a p-value of 0.0005 but item 6 was primarily used as a check variable since it asked about the level of involvement in launch, which for logistics was expected to be high. It was decided to eliminate item 6 from the construct. Therefore, there are 5 items for Logistics Involvement Magnitude. Item 4 asked about involvement magnitude in product development and item 5 asked about involvement in product testing, which had an MI of 117. Product testing is primarily done after a product is developed and in this case it was felt that it did not make logical sense to combine product development and testing together. Therefore, item 5 was deleted from the construct, which resulted in χ^2 = 16.07, CFI = .9746 and the highest MI = 15.0, which was viewed as acceptable.

All six items for Logistics Involvement Quality had regression weights significant at the 0.0001 level. Item 5 and item 6 had an MI of 57. Item 5 asked whether logistics was influential and item 6 asked if logistics directly impacted the outcome. Even though respondents might feel these questions were similar (if they are influential they also impact the project), it was decided not to combine these two items. The χ^2 = 71.83, CFI = .9625 and MI = 57.

There were 3 items for Logistics Involvement Relationship which, as explained earlier, cannot be evaluated with a resulting DF = 0 and so they were directly included in the measurement model.

All seven items for Product Performance had regression weights significant at the 0.0001 level. Item 4 asked if the project fell short or exceeded customer satisfaction objectives and item 7 asked about quality or performance objectives. MI was 44, which indicated there was a problem with either the items themselves or they needed to be combined. After reviewing the questions, it was felt Item 4 should be removed as customer satisfaction objective is not as easy to set or measure as the other output items. This left 6 items. The χ^2 = 48.7, CFI = .9453 and the highest MI = 13.3.

There were six items for Logistics Performance that had regression weights significant at 0.01. Item 1 asked if logistics costs were below average or above average, which might have been confusing as lower logistics costs is better and it needed to be reversed coded. The p value was .0169, which was different than all the other items that were significant at 0.0001. For this reason, it was decided to remove item 1. Even though the regression weights have acceptable p-values, the resulting CFI was only .7726, which was not acceptable. Item 2 and item 6 had a MI of 26.99, which suggested either the items have problems or they were asking very similar questions. Item 2 asks if orders were filled as requested, were far below average or far above average and item 6 asks about transit time to customers, which do not seem similar. Item 6 is reverse coded since if transit time was far above average then it took longer and that would be poor logistics performance. This might not have been clear to the respondents and so it was decided to remove Item 6. The remaining 4 items were significant at 0.0001. The χ^2 = 28.67, CFI = .8850 and the highest MI remaining was 26.51.

The χ^2, degrees of freedom and comparative fit index for the first order constructs are summarized in Table 4.5. As can be seen, the values for CFI are very high which suggests the items measure the constructs fairly well.

A measurement model for functional salience was tested where each of the first order constructs associated with functional salience was allowed to correlate with each other. The model can be seen in Figure 4.2. The χ^2 = 643.14, DF = 309, CFI = .9219 and no MI greater than 18.6 which is quite acceptable. Therefore, no further adjustments were made to the model.

A measurement model for the 2nd order construct Logistics Involvement was tested where each of the first order constructs associated with logistics involvement was allowed to correlate with each other. All items that had regression values for their respective constructs were significant at the 0.0001 level. The initial values were χ^2 = 959.78, DF = 335, CFI = .8994 and the highest MI was 50.54. The largest MI was between item 3 and the construct logistics involvement relationship that asked if logistics was valued by other team members. The other two items in logistics relationship asked if logistics was committed and cooperative. It was

TABLE 4.5 First Order Construct Items

Constructs	Items	χ^2, DF	CFI
Environmental Uncertainty	EU1, EU2, EU3, EU4, EU5	12.87, 5	.9764
Improving Information Technology	IIT1, IIT2-3, IIT4, IIT5, IIT6, IIT7	37.87, 9	.9422
Time and Quality Based Competition	TQBC1, TQBC2-3, TQBC4, TQBC5, TQBC6	21.26, 5	.9666
Global Factors	GF1, GF2, GF3	0, 0	1.000
Cross-Functional Integration	CF1, CF2, CF3, CF4, CF5	32.9, 5	.9782
Degree of Importance	DI1, DI2, DI3, DI4	33.8, 2	.9664
Advantage Provided	AP1, AP2, AP3, AP4	32.45, 2	.9570
Logistics Involvement Magnitude	LIM1, LIM2, LIM3, LIM4-5	16.07, 2	.9746
Logistics Involvement Quality	LIQ1, LIQ2, LIQ3, LIQ4, LIQ5, LIQ6	71.83, 9	.9625
Logistics Involvement Relationship	LIR1, LIR2, LIR3	0, 0	1.000
Product Performance	PP1, PP2, PP3, PP5, PP6, PP7	48.70, 9	.9453
Logistics Performance	LP2, LP3, LP4, LP5	28.67, 2	.8850

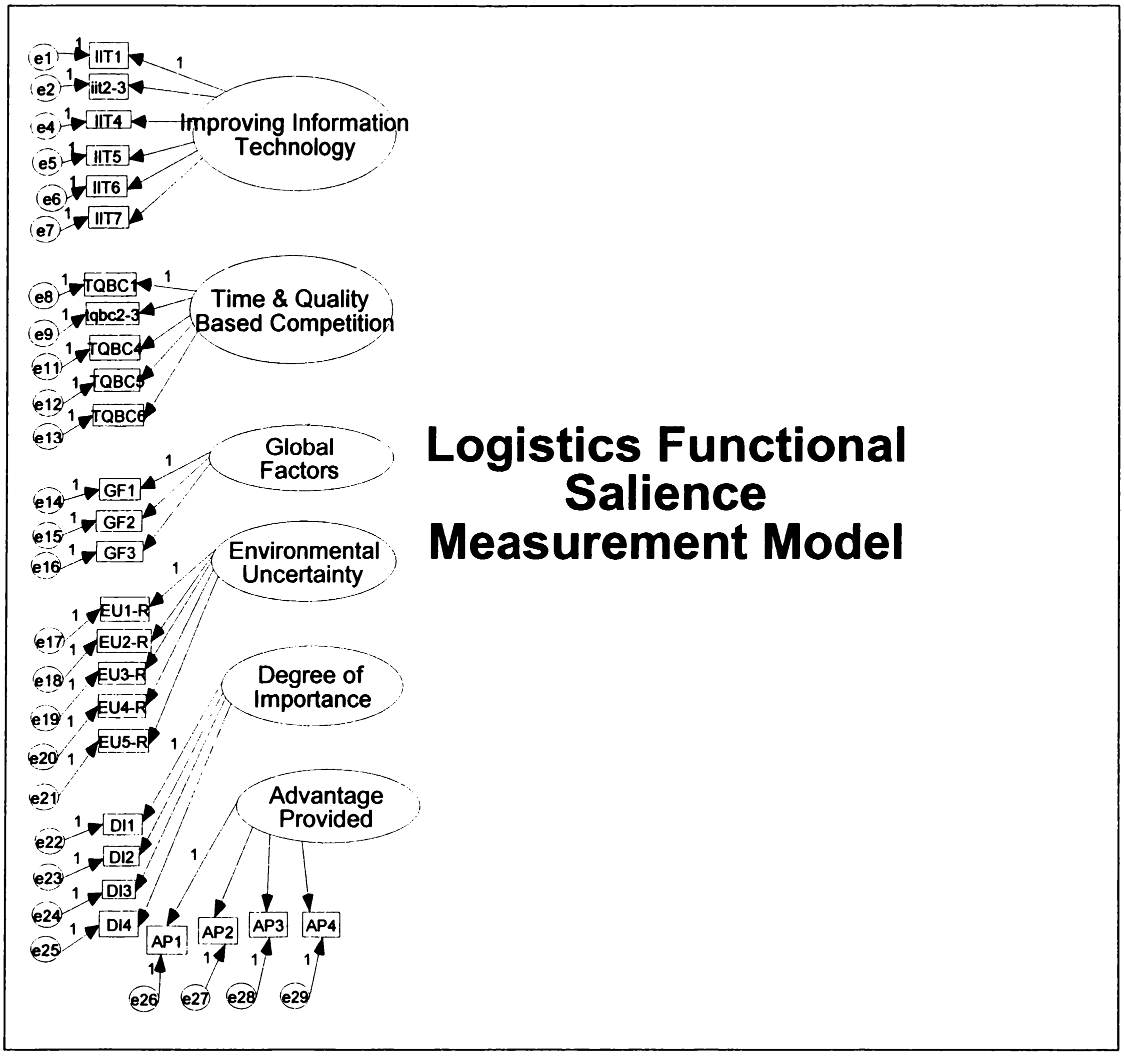

FIGURE 4.2 – Logistics Functional Salience Measurement Model

decided to delete item 3 because respondents might have a hard time deciding if other people valued them but they could relate to how committed and cooperative they were during the project. The resulting χ^2 = 814.42, DF = 309, CFI = .9121. The highest remaining MI = 46.07 was between item 5 and item 6 in involvement quality. Item 5 asked if logistics was influential during the project and item 6 asked if logistics directly impacted the outcome. The high MI suggests respondents could not distinguish between influence and impact when considering the quality of logistics involvement and it seemed logical to combine these two items. The resulting χ^2 = 698.42, DF = 284, CFI = .9233 and the highest MI = 24.90 were deemed acceptable. The resulting model can be seen in Figure 4.3.

STRUCTURAL EQUATION MODELING

Structural Equation Modeling using Amos 4.0 software was the statistical methodology used to test the hypotheses in this dissertation as discussed earlier in Chapter 3. The two measurement models were combined into a structural equation model that can be seen in Figure 4.4.

The starting values of putting both measurement models together were χ^2 = 2900.732, DF = 1317, CFI = .8445 and Root Mean Square Error of Approximation (RMSEA) = .0638. The initial fit indicies can be found in Appendix IV.

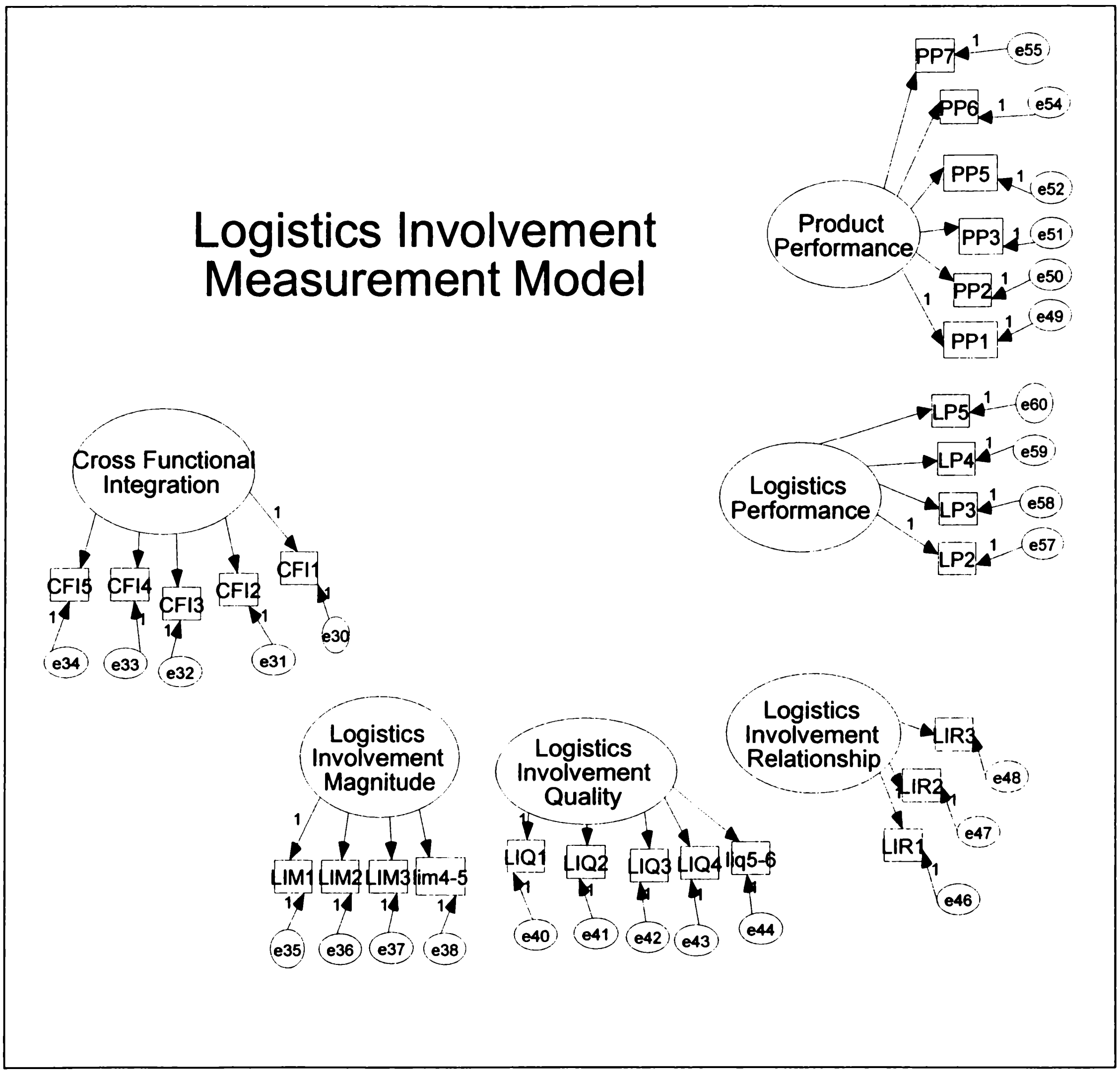

FIGURE 4.3 – Logistics Involvement Measurement Model

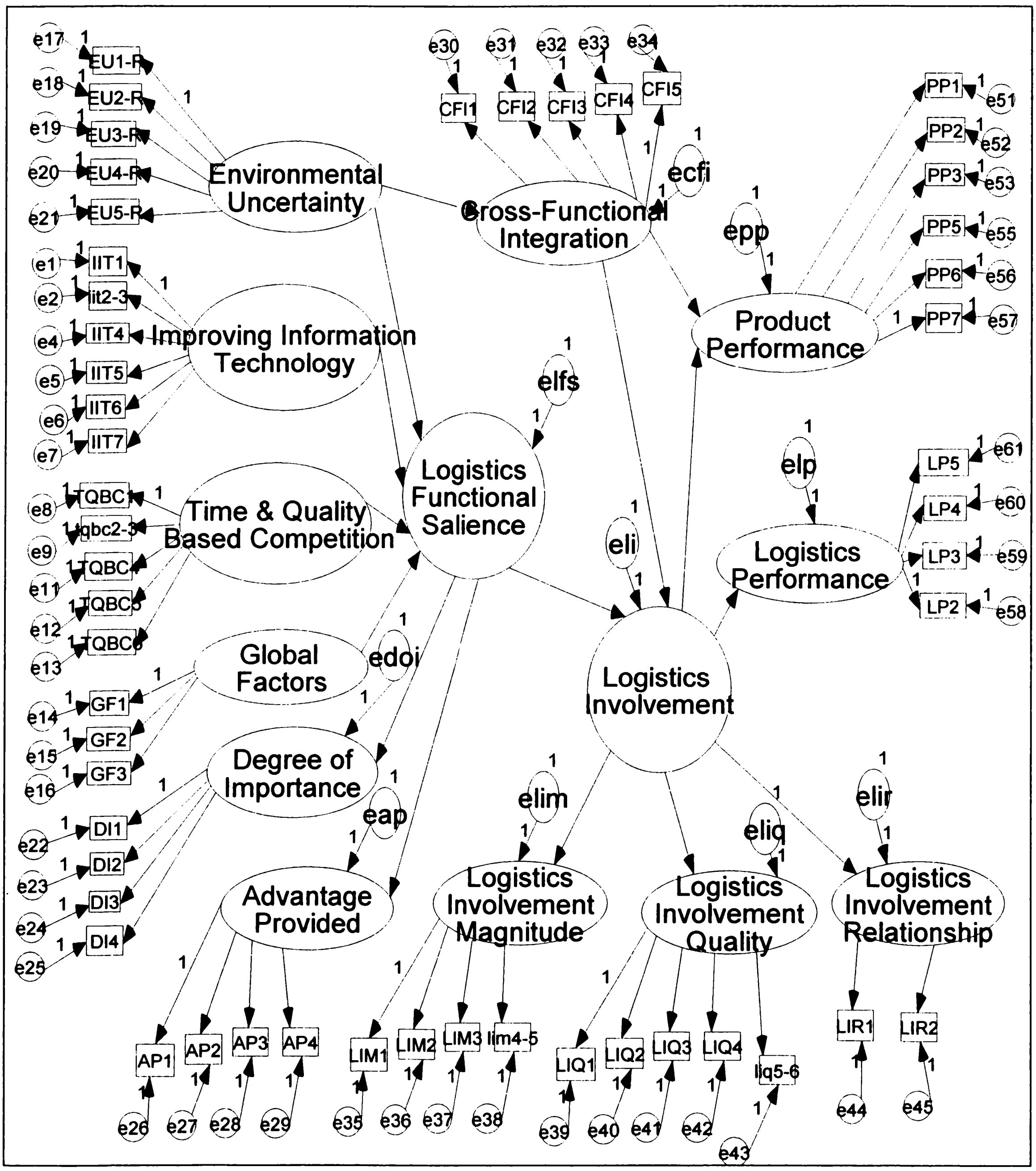

FIGURE 4.4 – Initial Structural Equation LINPD Model

The first step is to look at the regression weights to ensure they meet the 0.01 criteria. The arrow (regression weight) from Global Factors to Logistics Functional Salience had a p-value of .1769, which suggests Global Factors does not affect Logistics Functional Salience. Since Global Factors has no other hypothetical affect on any other constructs it was decided to remove it entirely from the model.

In the second iteration the arrow for Cross-Functional Integration to Product Performance was .1518, which suggests Cross-Functional Integration does not affect Product Performance. Therefore this arrow was removed from the model. The remaining regression weights or arrows were all significant at $p = 0.01$ which was acceptable. For this model $\chi^2 = 2611.95$, DF = 1169, CFI = .8472 and RMSEA = .0647.

In the third iteration it was decided to review the modification indices to ensure they were in the range of 10 – 20 and made theoretical sense. The highest MI was a value of 97.04 for covariance between time and quality based competition and information technology. Reviewing the items, it could be seen that there would be covariance between these two constructs, so a double headed arrow was placed on both constructs in the model.

In the fourth iteration the regression weight for time and quality based competition to logistics functional salience jumped to .2903, which was not significant, so it was decided that time and quality based competition and improving information technology were asking similar questions and both could not be in the same model. Improving information technology did not have as many items covary with items in other constructs and so seemed more stable compared to time and quality based competition. Therefore, time and quality based competition was removed from the model.

In the fifth iteration, the model $\chi^2 = 2026.15$, DF = 940, CFI = .8737 and RMSEA = .0626. All regression weights are significant at 0.01 level. For further improvements in the CFI and RMSEA it was necessary to look at the MI values. The highest value of MI remaining was 39.04 of covariance between improving information technology and environmental uncertainty. The construct of improving information technology is highly dependent on the environment and as the environment changes, information technology also changes. Therefore, a double headed arrow was added between improving information technology and environmental uncertainty.

In the sixth iteration the model had the following values: $\chi^2 = 1982.17$, DF = 939, CFI = .8787 and RMSEA = .0614. All regression weights were significant at the 0.01 level. The highest MI was related to the item made up of LIM 4-5 that seemed to covary with many of the other items in several constructs. These two items dealt with the magnitude of involvement during product development and testing. It seemed these two items were significantly different from the other 3 items for logistics involvement, which suggests logistics involvement during idea generation, idea screening and market analysis is different from logistics involvement during product development and product testing. Since this seems logical it was decided to remove LIM4-5 from the model.

In the seventh iteration the model had the following values: $\chi 2$ = 1852.52, DF = 896, CFI = .8907 and RMSEA = .0590. All regression weights were significant at the 0.01 level. The next highest MI was related to LIQ 5-6 which seemed to covary with many other items in several constructs. These items dealt with logistics being influential and directly impacting the outcome. It seems that those two items do not fit with the rest of the construct of logistics quality which dealt with creativity, independent contribution, ideas generated and ideas implemented, so it was decided to remove LIQ 5-6 from the model.

In the eighth iteration the model had the following values: $\chi 2$ = 1683.89, DF = 854, CFI = .8961 and RMSEA = .0574. All regression weights were significant at the 0.01 level. The highest MI was 28.04 between item 4 and item 5 for logistics performance. Item 4 deals with number of damage free deliveries and item 5 deals with utilization of transportation equipment. Since both these items really cannot be combined, it was necessary to eliminate one of these items. Item 5 was also covarying with items in other constructs, so it was decided to eliminate utilization of transportation equipment, which made the model more stable.

In the ninth iteration the resulting model had the following values: $\chi 2$ = 1539.16, DF = 813, CFI = .9074 and RMSEA = .0550. All regression weights were significant at the 0.01 level. There was only one MI at 28, while all other values were below 16. The 28 value for MI suggested the error terms for Degree of Importance and Advantage Provided are correlated. No further changes were made since the model surpasses the widely accepted value of CFI = .90 which suggests the model can be viewed as consistent with the data from which it was estimated. The $\chi^2 = 1539.16$, DF = 813 meets the requirement of the chi square to be approximately twice the degrees of freedom which suggests the model is consistent with the pattern of variances and covariances from the final sample data. The third requirement is that the RMSEA should be between .08 - .05, with the closer to .05 the better. Therefore the ninth and final iteration of the model was viewed as acceptable and significant. The resulting Logistics Involvement in New Product Development (LINPD) model, with the hypotheses included, is found in Figure 4.5. Appendix IV contains the complete listing of fit statistics for the initial model and final Logistics Functional Salience and Involvement Structural Model. The final model, with standardized values for the regression weights, is found in Figure 4.6.

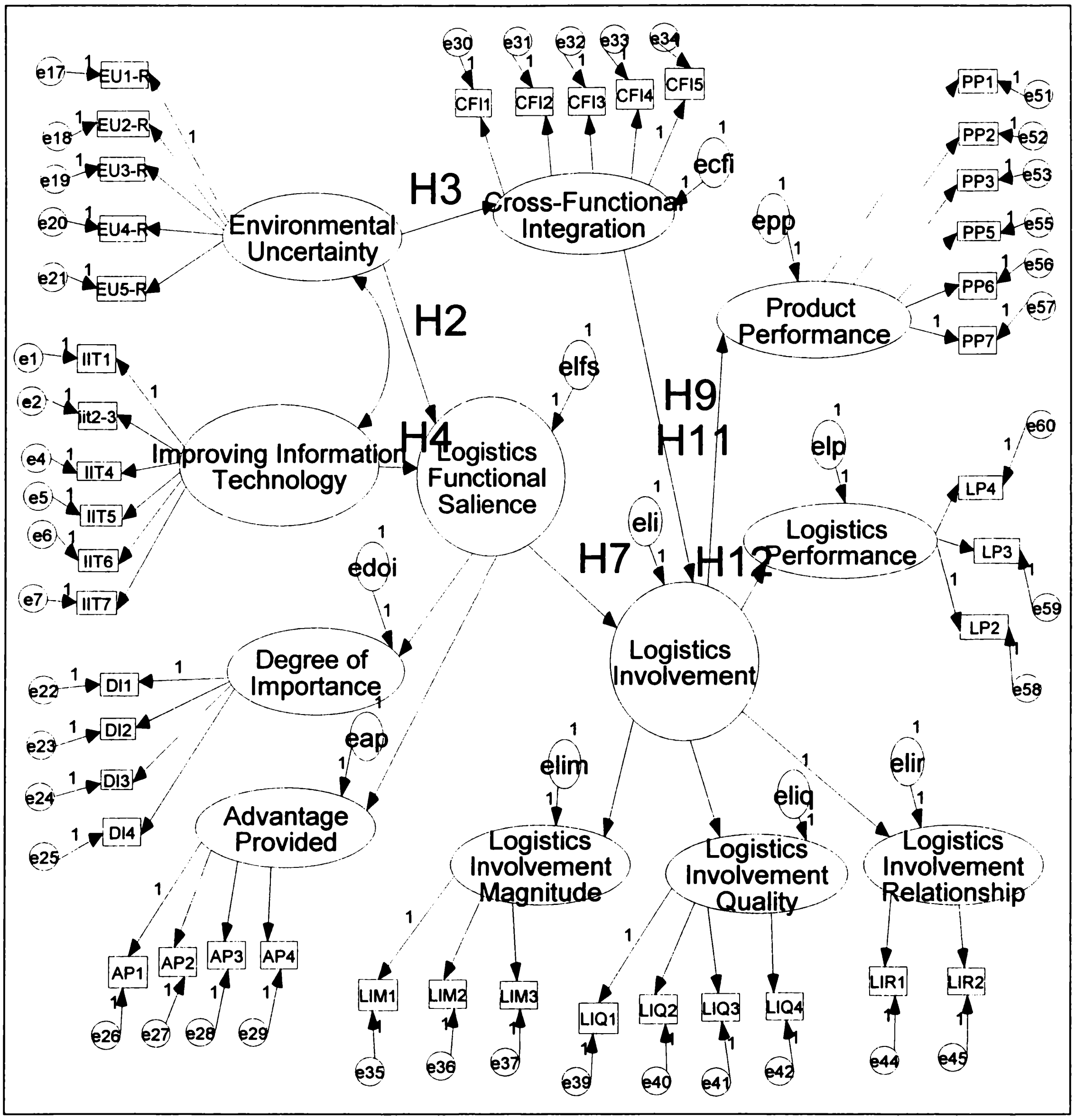

FIGURE 4.5 – Final Structural Equation LINPD Model

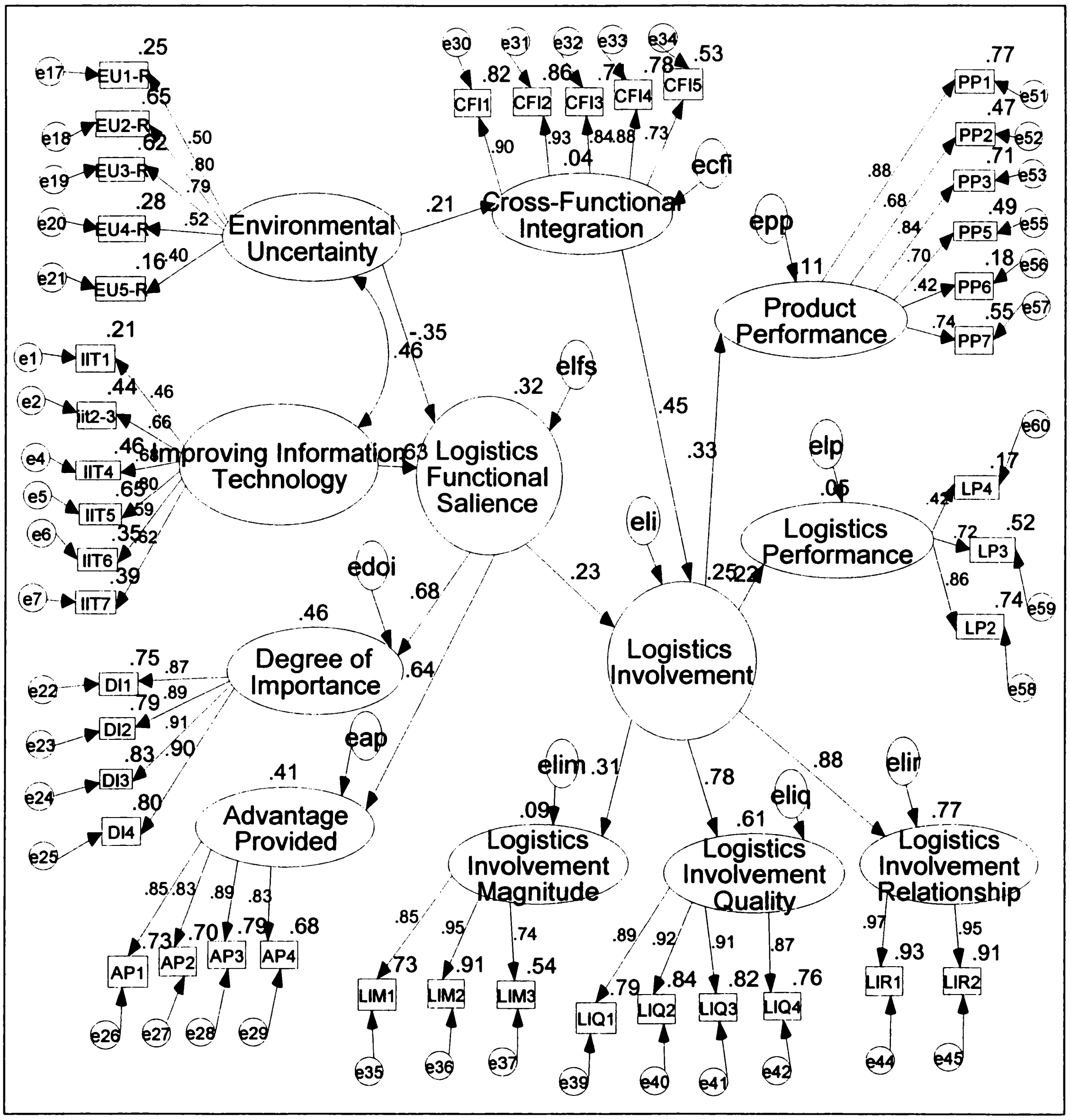

FIGURE 4.6 – Final Structural Equation LINPD Model with Standardized Values

HYPOTHESIS TESTS

This section uses the final model as developed in Figure 4.6 to test the 12 hypotheses originally presented in Chapter 2.

Hypothesis 1

Hypothesis 1 stated a positive relationship existed between environmental uncertainty and innovation level. Unfortunately the items used to measure innovation level did not load properly so this hypothesis was not tested.

Hypothesis 2

Hypothesis 2 stated a positive relationship exists between environmental uncertainty and logistics functional salience. The standardized regression value was -.35 which suggests an inverse relationship between environmental uncertainty and logistics functional salience. Based on the final model this hypothesis was not supported.

Hypothesis 3

Hypothesis 3 stated a positive relationship exists between environmental uncertainty and cross-functional integration. Based on the final model, the standardized regression value was .21 and the hypothesis was supported at the $p = 0.0000$ level of significance.

Hypothesis 4

Hypothesis 4 stated a positive relationship exists between improving information technology and logistics functional salience. Based on the final model, the standardized regression value was .63 and the hypothesis was supported at the $p = 0.0000$ level of significance.

Hypothesis 5

Hypothesis 5 stated a positive relationship exists between time and quality based competition and logistics functional salience. Based on the final model, this hypothesis was not supported.

Hypothesis 6

Hypothesis 6 stated a positive relationship exists between global factors and logistics functional salience. Based on the final model, this hypothesis was not supported.

Hypothesis 7

Hypothesis 7 stated a positive relationship exists between logistics functional salience and logistics involvement. Based on the final model, the standardized regression value was .23 and the hypothesis was supported at the $p = 0.0030$ level of significance.

Hypothesis 8

Hypothesis 8 stated a positive relationship exists between innovation level and logistics functional salience. Unfortunately, the items used to measure innovation level did not load properly so this hypothesis was not tested.

Hypothesis 9

Hypothesis 9 stated a positive relationship exists between cross-functional integration and logistics involvement. Based on the final model, the standardized regression value was .45 and the hypothesis was supported at the $p = 0.0000$ level of significance.

Hypothesis 10

Hypothesis 10 stated a positive relationship exists between cross-functional integration and new product performance. Based on the final model, this hypothesis was not supported.

Hypothesis 11

Hypothesis 11 stated a positive relationship exists between logistics involvement and product performance. Based on the final model, the standardized regression value was .33 and the hypothesis was supported at the $p = 0.0000$ level of significance.

Hypothesis 12

Hypothesis 12 stated a positive relationship exists between logistics involvement and logistics performance. Based on the final model, the standardized regression value was .22 and the hypothesis was supported at the $p = 0.0018$ level of significance.

The regression values for the hypothesis that were supported are summarized in Table 4.6

TABLE 4.6 Regression Values for Supported Hypothesis

Hypoth	Construct	Construct	Regr.	P-Value
H3	Environmental_Uncertainty	Cross-Functional_Integration	0.2104	0.0025
H4	Improv. Inform._Technology	Logistics_Functional_Salience	0.6335	0.0000
H7	Logistics_Functional_Salience	Cross-Functional_Integration	0.2321	0.0030
H9	Cross-Functional_Integration	Logistics_Involvement	0.4465	0.0000
H11	Logistics_Involvement	Logistics_Performance	0.2229	0.0018
H12	Logistics_Involvement	Product_Performance	0.3283	0.0000

SUMMARY

This chapter described the process used to analyze the survey data and the results of the analysis. The descriptive statistics, final sample demographics and the response were reported. It was also reported that nonresponse bias was not detected.

The results of scale confirmation using final sample data were reported for the measures developed in the pre-test and as discussed in chapter 3. Cronbach's alpha was utilized to test for scale reliability. Confirmatory factor analysis was used to test for unidimensionality of each of the constructs and the items used to measure the constructs. Two measurement models made up of the constructs were tested and, again, items that did not support the constructs were eliminated. A structural model made up of both measurement models was developed to test the hypothesis.

In conclusion, the survey data collected provided support for five of the ten hypotheses at $p = 0.001$ level of significance. A sixth hypothesis was not supported as it was inversely related compared to the original hypothesis but it was significant at the 0.001 level. The four remaining hypotheses were not supported from the data. The overall fit of the final model relating logistics functional salience and logistics involvement to new product development was supported with a CFI of .9074. The next chapter will discuss the managerial and theoretical implications of the findings from this chapter.

CHAPTER 5

CONCLUSIONS AND IMPLICATIONS

RESEARCH BACKGROUND

The research goal of this dissertation was to evaluate the involvement of logistics in new product development. Even though anecdotal evidence suggested there was a benefit of logistics involvement in new product development there was very little academic research that supported this proposition. This dissertation attempted to conduct research and develop theory to determine if there are benefits associated with early logistics involvement in new product development.

Two distinct streams of research were brought together in an attempt to improve the New Product Development (NPD) process for durable goods manufacturing firms. One stream of research considered contingency theory in organizational behavior research, which suggests that behavior within an organization is dependent on many factors, including the environment. The second stream of research looks at Cross-Functional Integration (CFI) in product development - the involvement of more than one function concurrently in product development. The new product literature is filled with examples of cross-functional product development utilizing R&D and marketing, R&D, marketing and manufacturing but rarely is logistics mentioned in the new product development process. This dissertation uses the literature that exists within both these streams to develop a framework that was used to analyze the key factors and potential challenges that are associated with the early involvement of logistics as part of a Cross-Functional team in new product development.

The literature review in Chapter 2, plus the 21 interviews conducted with logistics executives and new product managers, led to the development of an overall Logistics Involvement in New Product Development (LINPD) model. This LINPD model related environmental factors, leading to increased importance of logistics as a function, or logistics functional salience, which led to logistics involvement in new product development, which in turn led to improved product performance and logistics performance. This LINPD model was developed to answer the research questions postulated in Chapter 1.

RESEARCH QUESTIONS

The research questions were:

(1) As the environment changes does logistics as a function become more important?

(2) Do companies that have a cross-functional NPD process in place have greater NPD project success with logistics involvement?

(3) Do companies that rely on logistics for competitive advantage or where logistics is an important function benefit from direct logistics involvement in the NPD process?

(4) Does early logistics involvement in the NPD process affect project performance?

(5) Does early logistics involvement in the NPD process affect logistics performance?

(6) Does early logistics involvement effect on project performance depend on the level of innovation?

(7) Does early logistics involvement effect on logistics performance depend on the level of innovation?

The methodology on the process associated with answering these research questions was discussed in Chapter 3. Justification for using survey research methodology was provided in earlier chapters. In Chapter 3 the research design, including the unit of analysis, construction of the survey instrument, description of the sample population, data collection procedures and variable measures, used in this dissertation was discussed.

In Chapter 4, the analyses of the data and the results of the hypotheses testing were reported. First, descriptive statistics for the final sample were provided. The response rate, descriptive statistics and non-response bias were discussed. Reliability and construct validity were also examined for each construct based on the final sample data. The structural equation modeling technique was used to test the hypotheses.

In this chapter the results of the research in light of its conceptual, theoretical and management implications are reviewed. The conclusions and implications of the research are presented in the following three sections. The first section discusses the finding for each of the hypothesis tested in Chapter 4. The second section considers the theoretical contributions and managerial implications of this research. Finally, the limitations of this research and suggestions for future research are described.

DISCUSSION OF FINDINGS

In this section the results from each of the 12 hypotheses tested in Chapter 4 are discussed.

Hypothesis 1

H_1: *Companies that face an increase in environmental uncertainty will tend to produce higher levels of innovation level products.*

Hypothesis 1 was not tested .

Innovation Level was thought to be an important construct that considered how innovative and new the product was to the company. It was felt that environmental uncertainty would affect how innovative or new the product was which in turn would influence the level of logistics involvement. In other words logistics would have a different role to play in new product development depending on the level of innovation. The three measures used for the level of innovation were Improvement Level, Market Newness and Technology Newness. The purpose of this hypothesis was to test if higher levels of innovation ultimately lead to greater logistics involvement. Unfortunately the three items used to test for innovation level had a Cronbach's alpha of 0.55 and therefore could not be considered as reliably measuring the construct of innovation level. Since Cronbach's alpha was significantly below an acceptable level of 0.70 the innovation level construct was not included in the final model and the hypothesis was not tested.

Hypothesis 2

> H_2: *Logistics functions in companies that face an increase in environmental uncertainty will become more salient.*

Hypothesis 2 was not supported.

A very important construct in this dissertation is the concept of logistics functional salience or the importance of logistics within the firm compared to other functions within the firm as described in Chapter 2. Lawrence and Lorsch (1967) suggested the influence among the groups will vary depending on which functions have knowledge or certainty of information about particular environmental conditions. The importance or salience of particular functions within the organization will change as the environment changes. The environment varies along a certainty–uncertainty continuum and different functions play different roles within the firm.

Hypothesis 2 looked at the positive increase in salience for logistics depending on increasing uncertainty in the environment. The final model did show a negative relationship existed between environmental uncertainty and logistics functional salience (-.35) and at $p = 0.0016$ level of significance.

Environmental uncertainty explains 35% of the variance that is found in logistics functional salience. The inverse relationship suggests that as the environment gets more uncertain, logistics becomes less important or as the environment gets more certain logistics becomes more important. In first review the inverse relationship between uncertainty and logistics functional salience might seem counter intuitive. But it must be stressed that this survey was specifically looking at the role of logistics and the salience of logistics in relation to new product development.

Using transportation as an example, in new product development when the market environment is relatively certain then low cost and most efficient transportation would be the focus of product development suggesting logistics would play an important role. As new products are developed in a rapidly changing environment transportation costs will be a much smaller cost component, which in turn will reduce the importance of logistics. Therefore the data collected from this dissertation suggest that for new product development projects, logistics plays a greater role in certain environments where there is not as much change, as compared to new products developed for an uncertain constantly changing environment. Through this study it was found that as the environment becomes more certain, logistics as a function becomes more important.

It is useful to note that 55% of the respondents came from large companies with over 10,000 employees and 71% were in companies with over $1 Billion in sales and over 90% were in companies over 16 years old. Perhaps in larger companies, logistics is more focused on efficiency when it comes to new product development. This would explain that as the environment gets more uncertain logistics is not as salient. Would logistics play a different role in new companies that were less than 5 years old? This question is left for future research.

It is also interesting to note that, in the final model, environmental uncertainty also covaries with information technology (.46), which suggests that as the environment becomes more uncertain there is greater improvement in information technology. In other words companies invest in information technology to help handle the uncertainty that is found in the environment. As information becomes more important, technology is used to increase the quality and timeliness of the information.

Arranging these items from largest to smallest provides the following: product obsolescence (.80), technology obsolescence (.79), competitor actions (.52), change marketing practices (.50) and easy forecast demand (.40). One rule of thumb to determine how well the items actually relate to the construct is to check if the values for each item are similar and high. For the environmental uncertainty construct, the two obsolescence measures seem very similar but a value of 0.80 is not very high. The remaining three items all seem much lower and again might affect the conclusions drawn from this environmental uncertainty construct. In other words, if all five of the items had similar and very high values we would be more confident that the environmental uncertainty construct was accurately measured with the five items in the survey.

Hypothesis 3

> H_3: *Companies that face an increase in environmental uncertainty will encourage greater cross-functional integration during new product development.*

Hypothesis 3 was supported as a positive relationship (.21) and at p = 0.0000 level of significance.

Cross-functional integration is the involvement of more than one function concurrently in the product development process. In the past cross-functional integration primarily involved R&D and marketing, and sometimes R&D, marketing and manufacturing. An important aspect of this dissertation was to include logistics as another function that can benefit the integrated product development process. Other researchers have suggested all of the firm's functional departments need to be integrated during the NPD process (Ruekert 1987a).

With 21% of the variance in cross-functional integration explained by environmental uncertainty the findings of this dissertation research support the idea that greater environmental uncertainty leads to greater cross-functional integration. Gupta, Raj and Wilemon (1986) also related the degree of cross-functional integration for the firm depended on the firm's innovation strategy and the perceived environmental uncertainty within which the firm operates. As the environment becomes more uncertain more functions will be involved in the new product development process.

A single unit change in environmental uncertainty will translate to an increase in 0.21 in cross-functional integration. Arranging these items from largest to smallest provides the following: share information (.93), encouraged to work together (.90), achieve goals collectively (.88), share resources (.84), informally work as team (.73). These five items are fairly similar and high indicating a good representation of the Cross-Functional integration construct.

Hypothesis 4

H_4: *Logistics functions in companies that undertake improvements in information technology will become more salient.*

Hypothesis 4 was supported as a positive relationship (.63) and at $p = 0.0000$ level of significance.

Several researchers pointed to improving information technology as enabling logistics to (1) facilitate centralized strategic planning and day-to-day execution on a decentralized basis (Bowersox and Daugherty 1995), (2) restructure industry practices for distributing and supporting products (Lewis and Talalayevsky 1997), and (3) substitute information for inventory and influence strategic decisions and enable significant cost reductions (Rogers, Dawe, and Guerra 1991). In this dissertation the hypothesis that improvements in information technology have led to an increase in the importance of the logistics function within the firm was clearly supported.

The final model had five items made up of EDI, Real Time Product Tracking, Supply Chain Information Systems, Enterprise Resource Planning and Advance Planning and Scheduling Systems as originally proposed and two items, Internet and E-commerce, were combined as a single item as they were highly correlated. The result of this hypothesis test suggests that as companies improve or adopt new information technologies, logistics becomes more salient. Since there have already been significant improvements in information technology in the last few years this research suggests logistics as a function has become more salient. As more information technologies get used in business, companies could compete on efficient logistics processes, which would suggest logistics becomes more salient and there would be benefits in being involved in new product development.

Information technology explains 63% of the variance found in logistics functional salience. A single unit change in information technology translates to a 0.63 increase in logistics functional salience. The standardized values for the individual items that make up the construct of improving information technology can also be considered. The items have similar values, which supports the concept that these items make up a single construct. Arranging these items from largest to smallest provides the following: supply chain information systems (.80), real time product tracking (.68), internet/e-commerce (.66), APS (.62), ERP (.59), and EDI (.46). These results indicate supply chain information systems are of greatest value for improving information technology.

The theoretical implications are significant in that it suggests for logistics as a function to gain greater influence there is value in investing in information technologies such as supply chain information systems, real time product tracking and the internet/e-commerce. Having these information technologies allows logistics to make better decisions, which in turn leads to greater influence.

Hypothesis 5

H_5: *Logistics functions in companies that face an increase in time and quality based competition will become more salient.*

Hypothesis 5 was not supported.

Time and quality based competition can be defined as the elimination of waste in the form of time, effort, defective units, and inventory in manufacturing distribution systems (Mentzer 1999). In this dissertation time and quality based competition (TQBC) was based on 6 items, JIT, QR, VMI, CR, ECR, CPFR. Unfortunately, these technologies are highly correlated with the items used to measure information technologies tested in Hypothesis 4. The survey data indicate time and quality based competition is highly dependent on sophisticated information technology to work. Therefore both the information technology construct and TQBC were taping the same underlying concept of new technology. TQBC does have a role to play in improving logistics functional salience but in this model TQBC took a secondary role to information technology. The items loaded very well and the factor is important but there was confounding between information technology and TQBC. This led to the elimination of TQBC as a construct for this particular research. Since the construct loaded so well, it is suggested TQBC be used in other research where information technology is not included.

Hypothesis 6

H_6: *Logistics functions in companies that face an increase in global factors will become more salient.*

Hypothesis 6 was not supported.

Global Factors, made up of global sourcing, global competition and global manufacturing, should affect logistics salience. Unfortunately global factors were highly related to environment and information technology. It is possible to note that global factors have become more prevalent because of improvements in information technology and improvements in TQBC. All three of these constructs are related and, in new product development become highly correlated, which leads to confounding errors. This led to the elimination of global factors as a construct but since the items loaded well it is suggested that global factors be used in other research that does not have TQBC and information technology in the same model.

Hypothesis 7

H_7: *Companies that use logistics for a competitive advantage or where the logistics function is salient will have greater logistics involvement in new product development.*

Hypothesis 7 was supported as a positive relationship (.23) at p = 0.0000 level.

Lawrence and Lorsch (1967) suggested the influence among groups will vary depending on which functions have knowledge or certainty of information about particular environmental conditions. The salience of functions within the company will change as the environment changes. This is a very important construct in this dissertation and the data clearly support the concept that companies where the logistics function is salient will have greater logistics involvement. This suggests a benefit exists for companies to have logistics involved in new product development especially if logistics is a salient function within the company. This dissertation used the concept of changing influence to present the concept that logistics has become more important within the firm, especially through improvements in information technology and when the environment is more certain. As discussed previously both these factors lead to greater logistics functional salience.

To further understand the logistics functional salience construct it is useful to consider the two input constructs, environmental uncertainty and improving information technology. The direct influence of information technology on logistics functional salience is .63 and uncertainty in the environment is -.35. In other words 63% of the variance in logistics functional salience is explained by information technology and 35% of the variance is explained by environmental uncertainty. The influence of information technology in absolute terms is more than twice the influence of uncertainty. This suggests investments in information technology lead to greater logistics functional salience in new product development.

There are two indicator constructs for logistics functional salience. The first indicator construct was degree of importance of logistics within the firm. The items from most significant to the least are: access (91), influence (.90), visibility (.89) and importance (.87). The difference between these 4 items seems so small (.04), the values are so similar and since all the values are so high suggest that all four items would be excellent measures of the degree of importance construct. The degree of importance measure is not unique to logistics, which suggests it is possible to use these items to measure the importance of other functions within the firm.

The second indicator construct for logistics functional salience is the advantage provided by logistics to the firm. The items from most significant to least significant in terms of advantage are: competitive (.89), cost (.85), service quality (.83), and profitability (.83). The difference between these 4 items again seems so small (.06), the values are so similar and since the values are relatively high suggest that all four items would be excellent measures of the degree of advantage construct. The advantage provided is also not unique to logistics, which again suggests it is possible to use these items to measure the advantage provided by other functions within the firm.

The next issue to consider is the relationship between the indicator constructs and logistics functional salience. The value .64 for degree of importance is highly similar to the value of .68 for advantage provided. The similarity suggests both constructs are related to logistics functional salience at the same level. The slightly higher number for advantage provided might suggest there is greater logistics functional salience as more advantage is provided by logistics. Another way to consider the results is to state that LFS explains 64% of the variance in degree of importance and 68% of the variance in advantage provided.

One of the strengths of structural equation modeling is that indirect effects on different constructs can also be considered. Environmental uncertainty has an indirect effect of -.2230 and improving information technology has an indirect effect of .4066 on advantage provided. This suggests improving information technology has a positive indirect effect on the advantage provided by logistics and environmental uncertainty has a negative effect on advantage provided.

Environmental uncertainty has an indirect effect of -.24 and improving information technology has an indirect effect of .43 on degree of importance. This suggests improving information technology has a positive indirect effect on the degree of importance provided by logistics and environmental uncertainty has a negative effect on degree of importance provided by logistics.

The data clearly support the idea that companies where logistics is salient will have greater logistics involvement in new product development. Logistics functional salience is dependent on improvements in information technology and as the environment becomes more certain. Note this relationship only holds when discussing new product development.

Hypothesis 8

H_8: *Companies that are developing highly innovative products will have greater logistic involvement.*

Hypothesis 8 was not tested.

Innovation level as discussed earlier was not included in the model as the items did not meet the requirements of a Cronbach alpha above .70.

Hypothesis 9

H_9: *Companies that have higher levels of cross-functional integration will have higher levels of logistics involvement.*

Hypothesis 9 was supported as a positive relationship (.45) and at $p = 0.0000$ level of significance.

Cross-functional integration as discussed earlier is the involvement of more that one function concurrently in the product development process. This hypothesis suggests companies that already use cross-functional integrated product development will also have higher logistics involvement. In another sense this also suggests companies who currently use Cross-Functional integrated methods of product development would benefit from logistics involvement. The relationship between cross-functional integration and logistics involvement is .45 so that 45% of the variance in logistics involvement is explained by cross-functional integration. A single unit change in cross-functional integration will cause a change of 0.45 in the likelihood of logistics involvement.

The second construct that leads to logistics involvement is logistics functional salience. Logistics functional salience as described earlier considers the importance of logistics within the firm. The relationship between logistics functional salience and logistics involvement is .23, so that 23% of the variance in logistics involvement is explained by logistics functional salience. A single unit change in cross-functional integration will cause a change of 0.23 in the likelihood of logistics involvement. As logistics becomes more important for the firm there is greater value in logistics involvement in new product development. The magnitude of the effects of cross-functional integration, which is almost twice logistics functional salience, suggests companies that have cross-functional integrated product development would be more likely to have logistics involvement.

Logistics involvement is an important part of the model and is really the focus of this dissertation. This dissertation hypothesized that logistics involvement in the new product process will benefit NPD project performance and logistics performance. Therefore LI represents the degree and influence that logistics has on the NPD process. Logistics involvement is a second order construct that relates the level of logistics interaction throughout the new product development process. This construct in a sense measures the activity of logistics in the new product process.

The indirect effects on the different constructs can also be considered for logistics involvement from largest to smallest. Improving information technology has an indirect effect of .15 and environmental uncertainty has an indirect effect of .01 on logistics involvement. Interestingly, environmental uncertainty has a positive but very small relationship with logistics involvement, but clearly, as the direct effects indicated, earlier logistics involvement is much more influenced by information technology.

There are three indicator constructs that directly affect logistics involvement: logistics involvement magnitude, logistics involvement quality and logistics involvement relationship. Logistics involvement magnitude is made up of three items that specifically ask the level of involvement of logistics during the first 3 stages of new product development: idea generation, idea screening and market analysis. The items from most significant to least significant are: idea screening (.95), idea generation (.89), and market analysis (.74). The first two items are relatively similar and fairly high which suggest they would be good indicators for logistics involvement. Unfortunately market analysis is not quite as high and might not be as good an indicator of involvement magnitude.

Logistics involvement quality is made up of four items that ask about the influence or the value of logistics in the new product process. The items from most significant to least significant are: independent contribution (.92), ideas generated (.91), creativity (.89), and ideas implemented (.87). These four items are similar in magnitude and very high which suggests these items are good measures of the quality of logistics involvement in new product development.

Logistics involvement relationship is made up of 2 items that ask about the type of relationship between logistics and other team members. The items from most significant to least significant are highly committed (.97) and highly cooperative (.95). Both these items are similar in magnitude and very high which suggest these items are good measures of the relationship between logistics and new product development.

The next issue to consider is the relationship between the indicator constructs of involvement magnitude, involvement quality and involvement relationship with the construct of logistics involvement. The three indicator constructs from largest to smallest in terms of direct effect are: involvement relationship (.88), involvement quality (.78), and involvement magnitude (.31). The large difference between these constructs can be viewed as problematic. Even though the items for the constructs load well and the regression weights are highly significant it would have been better to have similarity in regression weights as the other constructs. Logistics involvement explains 31% of the variance in involvement magnitude, 78% of the variance in involvement quality and 77% of the variance in involvement relationship.

The indirect effects on each of the indicator constructs can also be considered starting with logistics involvement magnitude. Arranging the indirect effects from largest to smallest leads to the following: cross-functional integration (.14), logistics functional salience (.07), improving information technology (.05) and environmental uncertainty (.01). This summary shows the strength of the underlying constructs that might have an effect on logistics involvement magnitude.

Arranging the indirect effects from largest to smallest for logistics involvement quality leads to the following: cross-functional integration (.35), logistics functional salience (.18), improving information technology (.12) and environmental uncertainty (.01). This summary shows the strength of the underlying constructs that might have an effect on logistics involvement quality.

Arranging the indirect effects from largest to smallest for logistics involvement relationship leads to the following: cross-functional integration (.39), logistics functional salience (.20), improving information technology (.13) and environmental uncertainty (.01). This summary shows the strength of the underlying constructs that might have an effect on logistics involvement relationship.

Hypothesis 10

H_{10}: *Companies that have higher levels of cross-functional integration will have greater new product performance.*

Hypothesis 10 was not supported.

It was surprising that the relationship between Cross-Functional Product Development (CFPD) and new product performance was not significant. According to the literature CFPD leads to reduced development lead times with fewer costly redesigns, better communication, reduction in duplication, cost savings from lower maintenance, more reliable products with fewer recalls, and enhanced customer satisfaction (Cooper 1979; Souder 1987; Dowlatshahi 1992). It is unclear why CFPD did not directly lead to improved product performance. This will have to be addressed as part of future research.

Hypothesis 11

H_{11}: *Companies that have higher levels of logistics involvement will have greater logistics performance.*

Hypothesis 11 was supported as a positive relationship (.22) at $p = 0.0018$ level of significance.

Logistics performance is one of two outcome constructs from the final model and is very important. The fact that logistics involvement leads to better logistics performance bodes well for the concept of logistics involvement in new product development. Twenty-two percent of the variance in logistics performance is explained by logistics involvement.

Two of the items, order fill rate and on time delivery were from Chow, Heaver, and Henriksson (1994) while damage free delivery was obtained from the expert interviews. Logistics performance has not been adequately defined in the literature and even though there were six items in the original survey they all did not load very well which left a final group of 3 items. Arranging the items from most significant to least significant are order fill rate (.86), on time delivery (.72) and damage free delivery (.42). The first two items, order fill rate and on time delivery, are both high and relatively similar but unfortunately damage free delivery did not load as well. Another problem is that many respondents might not have considered damage free delivery an indicator of logistics performance.

Arranging the indirect effects from largest to smallest for logistics performance leads to the following: cross-functional integration (.10), logistics functional salience (.05), improving information technology (.03). This summary again shows the strength of the underlying constructs that might have an effect on logistics performance.

Hypothesis 12

H_{12}: *Companies that have higher levels of logistics involvement will have greater new product project performance.*

Hypothesis 12 was supported as a positive relationship (.33) at $p = 0.0000$ level of significance.

Project performance is the key output construct in this model. The purpose of this dissertation to a large part is to improve performance of new product development projects. Thirty-three percent of the variance in project performance was explained by logistics involvement. Therefore it was very important to show that logistics involvement in new product development leads to better project performance. Project performance had six items which loaded very well: profit, budget, market share, competitive advantage, speed to market and quality/performance. Arranging the items from most significant to least significant are profit (.88), market share (.84), quality/performance(74), competitive advantage (.70), budget (.68), and speed to market (.42). Profit and market share seem very similar and load very well to project performance. These two items are also common in both the academic and practitioner literature as examples of project performance. Quality, competitive advantage and budget also seem similar in terms of loading and good items for project performance. Speed to market seems much lower than the others and this could be because many respondents did not know how long it took to get a product to market or whether it was a faster or slower process.

Arranging the indirect effects from largest to smallest for project performance leads to the following: cross-functional integration (.15), logistics functional salience (.08), and improving information technology (.05). This summary shows the strength of the underlying constructs that might have an effect on project performance.

The two outcome performance variables are logistics performance and project performance. Logistics performance had a regression weight of 0.22 and project performance had a regression weight of 0.33. This suggests even though logistics involvement had a positive effect on logistics performance, logistics involvement had a greater effect on project performance. One possible reason that this happened is project performance measures are more common and the respondents are more familiar with those measures.

RESEARCH QUESTIONS ANSWERED

A number of the original research questions that prompted this dissertation were answered.

The first research question asked if logistics becomes more important as the environment changes. This dissertation does show that if the environment becomes more certain, or if information technology is adopted by the firm, logistics becomes more important or salient within the firm.

The second research question asked if companies that have a cross-functional NPD process in place have greater NPD project success with logistics involvement. The data from this dissertation suggest companies with cross-functional integration and logistics involvement have greater NPD project success.

The third research question considered if companies where logistics provides competitive advantage or where logistics is an important function benefit from direct logistics involvement in the NPD process. The data again support this assertion. Companies where logistics is functionally salient have greater NPD success with logistics involvement in new product development.

The fourth research question focused on whether early logistics involvement in the NPD process affects project performance. Since early logistics involvement is defined in this dissertation as involvement before product launch, there is support for early logistics involvement in new product development leading to better project performance. The dissertation did not try to differentiate between early logistics involvement but used it as a categorical variable. Early logistics involvement was not part of the model so there is no clear and direct differentiation between early logistics involvement and logistics involvement. As can be seen by Table 5.1 only 4.4% of respondents were involved when the product was started but 48% were involved at 50% product development. Therefore, it is possible to state that almost 50% of the sample had logistics involved in new product development before 50% of the development was completed. This supports the idea that logistics has a direct benefit to improve project performance if logistics is involved in new product development.

Table 5.1

Frequency of Logistics Involvement vs. Percent Product Development

	Percent Complete	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 (0%)	13	4.4	4.4	4.4
	2	44	14.9	14.9	19.3
	3	42	14.2	14.2	33.4
	4 (50)%	43	14.5	14.5	48.0
	5	61	20.6	20.6	68.6
	6	52	17.6	17.6	86.1
	7(100%)	41	13.9	13.9	100.0
	Total	296	100.0	100.0	

The fifth research question focused on early logistics involvement in the NPD process affecting logistics performance. The answer is the same as stated for the previous question, that is, logistics involvement during NPD leads to better logistics performance. Early logistics involvement did lead to better logistics performance but it is not clear how early logistics has to be involved to be of most effective benefit. This can be addressed as part of future research.

The sixth question asked if early logistics involvement has a different effect on project performance depending on the level of innovation. Unfortunately the data did not provide an answer since the level of innovation construct was not measured properly and this question, and the associated hypothesis, was not tested.

The seventh question asked if early logistics involvement has a different effect on logistics performance depending on the level of innovation. Again since the innovation level was not able to be determined properly, the associated hypothesis was not tested and this research question could not be answered.

CONTRIBUTIONS OF THIS DISSERTATION

There were several important contributions from this dissertation. In the following sections, the knowledge contributions are discussed from both a theoretical and managerial perspective.

Theoretical Implications

This dissertation research contributes to the body of knowledge in two ways, by filling gaps in the knowledge base and by substantiating previous research. The general theoretical implications are discussed in this section.

The first theoretical implication is the concept of functional salience and specifically logistics functional salience as discussed in relation to hypotheses 2, 4, 5, 6 and 7. As described previously by Lawrence and Lorsch (1967) contingency theory was substantiated by this research, in that changes in the environment cause changes in the firm. This dissertation added to this concept by suggesting that different functions within the firm change in influence or become more salient as the environment changes.

Logistics functional salience is also a valuable construct for logistics research. Researchers have long suspected logistics as a function has become more salient within the firm and plenty of research has been conducted that addresses the valuable role played by logistics within the firm. This dissertation adds to that body of research by specifically looking at changes in the environment that affect the salience of logistics. Three new input measures for logistics functional salience that reflected environmental changes were developed: improving information technology, time and quality based competition and global factors. Environmental uncertainty was an existing measure that was shown to affect logistics functional salience as well. By identifying other environmental changes it should be possible to evaluate the salience of other functions within the firm. Even though time and quality based competition and global factors were shown to correlate highly with improving information technology it should be noted that both these constructs had items that loaded very well. These constructs and their associated measures could be used in other research where it might be useful to consider the effects of time and quality based competition and global factors.

This dissertation also developed a scale that accurately measures logistics functional salience (LFS), which has broad implications for researchers. Logistics researchers can substitute other input factors found in the environment external to the firm such as government regulation/deregulation and determine the effect on logistics salience. It might also be possible to consider input factors internal to the firm that might affect the salience of logistics such as a centralized/decentralized organization. Clearly logistics researchers can adapt this scale to the many situations where research is contingent on the context of the phenomena being studied.

The LFS scale would also be useful for new product development researchers who are interested in the salience of other functions within the firm, such as R&D, marketing or manufacturing. The LFS scale does not use any items that are unique to logistics, which suggests it would be possible to adapt this scale for other functions within the firm as needed. It might also be possible to adapt the LFS scale to contexts beyond the firm level, such as supply chains. In other words does the salience of the retailer or manufacturer change within a supply chain as the environment changes?

It is also possible to conceive of applications of the LFS scale to contexts other than new product development research. Perhaps researchers might use the LFS scale to determine the importance of a particular function or a particular initiative such as quality management in contexts that have nothing to do with new product development.

The second theoretical implication of this research is the idea that logistics in new product development becomes less salient or less important as the environment gets more uncertain. This particular finding might be related to the level of innovation where logistics plays a greater role in incremental innovation. It is unfortunate that the level of innovation was not tested in this dissertation to determine if logistics plays a different role with radical innovation under increasing environmental uncertainty. The implication of this research does not fit very well with other research that suggests logistics can play a more important role as the environment gets more uncertain. In this case flexibility and being able to adapt to changing conditions suggests logistics plays a more prominent role. Therefore this theoretical implication must be viewed with caution and future research needs to be conducted to understand the implication of logistics becoming less salient as the environment changes.

The third theoretical implication of this dissertation research is the role of logistics in new product development as discussed in hypotheses 11 and 12. There has been very little research that specifically examined the role of logistics in new product development. This research added to the body of knowledge in both logistics and new product development by showing that logistics involvement in new product development prior to launch is of benefit to NPD project performance and logistics performance.

The fourth theoretical implication is the support provided to the relationship between environmental uncertainty and cross-functional integration. As described previously, several researchers have noted the relationship between increasing environmental uncertainty and increasing cross-functional integration. Interestingly this was found to be true for new product development. Are there other major activities within the firm that would benefit from a more cross-functional approach?

Managerial Implications

The first managerial implication is the basic concept that logistics should be involved earlier in new product development process. Having logistics involved earlier in new product development is of direct benefit both to NPD project performance and logistics performance. Over fifty percent of the companies in this survey had logistics involved before 50% product completion. Many companies are involving logistics earlier in new product development and this research shows it directly benefits logistics and project performance. This is a huge implication as the converse is that 50 percent of the companies do not have logistics involved in product development, which might affect the logistics and project performance of their NPD projects. Companies are constantly searching to improve NPD project performance and NPD is essential for long-term survival. Much of the academic literature suggests companies still do a poor job of NPD and this research, which suggests logistics involvement in NPD would be of direct benefit, should be of great value for companies who do not currently involve logistics in NPD.

The second managerial implication is to consider the benefit of investing in information technologies such as EDI, Internet, E-commerce, real time product tracking, supply chain information systems and enterprise resource planning systems as discussed in this dissertation. By investing in information technology, logistics has greater capability to manage the logistics process, which is reflected in the significance and benefits as discussed earlier associated with information technology.

The third managerial implication is to consider investing in information technologies if the environment is uncertain. Since both constructs are highly correlated there would be benefit in information technology independent of the benefits of logistics involvement. Information technology also plays a role in reducing uncertainty, as having more information suggests less uncertainty. The popular literature suggests the business environment is increasing in uncertainty and information technology is constantly improving. This research provides empirical support to the concept that environmental uncertainty and improving information technology are related and increasing environmental uncertainty should lead to increasing investment in information technology.

The fourth managerial implication is to ensure that if a cross-functional integrated process is currently being used in new product development then there is benefit in ensuring logistics is involved in new product development. This is a very important implication since a large majority of the companies had cross-functional integrated product development and those companies would benefit from logistics involvement in NPD.

The fifth managerial implication is to involve logistics in new product development if logistics is used for competitive advantage or if logistics is a salient function within the firm. According to this research, logistics is increasing in salience within the firm as a result of changes in the environment. As logistics increases in salience, having logistics involved in NPD leads to better logistics and product performance.

The sixth managerial implication is to consider that if the market environment for the product is uncertain there might be less benefit of logistics involvement in new product development. This is a contingency relationship that suggests if the environment becomes more certain then logistics should be involved. In the current business climate greater environmental certainty might be a rarity but examples do exist such as mature, stable, perhaps regulated markets. In these stable environments logistics can play a role in NPD that would lead to better project and logistics performance.

The seventh managerial implication is the increase in logistics functional salience within the firm. This dissertation research suggests logistics has become more salient within the firm. Managers might consider involving logistics in other activities where logistics currently might not play a prominent role such as forecasting or product promotion.

LIMITATIONS

This dissertation research has a number of limitations that can affect the conclusions and interpretation of the results that have been discussed.

Kerlinger (1986) identified the two limitations of mail survey research are non-response bias and inability to check responses. Even though two different non-response bias tests were used and no evidence of non-response bias was found in either of the tests, it can still be a real problem. While a response rate of 36.8 percent is good for an executive survey, it is still possible that this group of executives did not represent the population and non-response bias did exist. Perhaps the 63% who did not choose to respond included companies where logistics played no role in new product development, which might affect the results of this research.

The inability to check response accuracy was acknowledged and no attempt was made to validate the actual responses. Some of the respondents might not have been involved in both new product development and logistics so they might not have known all the answers but they might have chosen to respond anyway.

This survey used the CLM mailing list of past conference attendees as the source of respondents to ensure the survey reached firms where logistics was a recognized and distinct function within the firm. This inherently creates a positive bias towards logistics involvement. There are thousands of manufacturing firms within the US who employ logisticians but who do not send their employees to the CLM conference.

This survey only targeted firms with US addresses, which might suggest the results only apply to American firms. Again this might create bias towards specific logistics practices that are uniquely American.

Survey research, to raise the response rate, is constrained by the need to be of limited size, standardized responses and easy to use. This limited the number and type of questions that can be asked. It would be of value to obtain more information from each respondent, to ensure there are a greater number of items for each measure but this would lead to a survey that very few respondents would fill out.

During the time period of this survey, March – April 2001, there was a downturn in the economy, and many respondents indicated they did not have the time to fill out a survey in the midst of all the changes in the economy. Some of the results might have been affected by the turbulence in the economy.

The statistical technique used to test the hypotheses was structural equation modeling, which has many advantages as discussed in Chapter 3. Unfortunately, as with any statistical technique there are disadvantages. Although the model of logistics involvement in new product development was built on theory-based inference of causality between variables, SEM cannot truly test for causality. Only by stringently controlling the variables in an experiment is there a possibility of determining causality. This was not possible since the data were collected through self-administered surveys where little control could be exercised over both experimental and extraneous variables.

Finally, another problem with developing new theory is the robustness of the measures that are used. As with many statistic tests, the validity of the results is largely dependent on the validity of the original measures developed. Many of the measures were newly developed or adapted for this research and further research must be conducted to assure these measures are valid. Developing reliable measures is an ongoing process and can only be achieved through multiple research studies.

SUGGESTIONS FOR FUTURE RESEARCH

There are a number of new areas that need to be explored as part of a future research stream in this area. The first area of research would be to develop a better measure for innovation level. There would be a lot of value in determining if there is a relationship between logistics involvement and level of innovation. Is there greater benefit in logistics involvement with higher levels of innovation?

The second area of research would be to develop more constructs that might impact logistics functional salience that would not covary with improving information technology. Additional constructs that would help improve the validity of the logistics functional salience construct include deregulation, market expansion, and technological advances (independent of information technology).

The third area of research would be to develop additional items for logistics involvement relationship. Logistics relationship had only two items and a two item construct does not allow the calculation of Cronbach's alpha. It is preferable to have four or five items for one construct. Logistics relationship seems to be an important part of logistics involvement and there would be value in developing a good measure.

The fourth area of research would be to develop better measures of logistics performance. Logistics performance seems to be an under researched area in logistics. By developing better measures of logistics performance there would be a benefit not only in new product research but also other logistics research.

A fifth area of research would be to consider the demographics of the companies in question. One possibility would be to focus the research on companies that are a certain size in terms of sales and employees, certain age or from a particular industry. Logistics might play a different role in companies that are small in size compared to multinational companies and it would be interesting to focus on specific demographics. Would logistics play a different role in new companies that were less than 5 years old? Logistics plays different roles in different industries and it might be interesting to research the differences. It would also be useful to find companies that had a lot emphasis on new products where a majority of the profit in the company came from products less than five years old.

A sixth area of research would be to expand beyond the firm and consider the supply chain. Logistics plays a significant role in the supply chain and it would be of value to determine if logistics involvement helps NPD across firms in the same supply chain.

A seventh area of future research would be to replicate this study with a different set of survey respondents who are not necessarily members of CLM. It would be of value to determine if respondents who are not as familiar with the logistics function would have the same responses.

An eight area of future research would be to replicate this study with international firms as opposed to U.S. firms alone. Perhaps the global factors construct might become more important for respondents from international companies. International respondents would have a different perspective on many of the constructs used in this research and incorporating their responses would increase the robustness of the constructs.

A ninth area of future research would be to do a more qualitative in-depth study of companies who had new product projects with logistics involvement and new product projects without logistics involvement. A case research methodology might provide a different perspective on the research questions addressed in this dissertation. This would facilitate the direct comparison of many of the factors to determine the direct benefit of logistics involvement in NPD.

A tenth area of research would be to identify which of the five stages of product development or at what percent of completion is most appropriate for logistics involvement. Early logistics involvement did lead to better logistics performance but it is not clear how early logistics has to be involved to be of most effective benefit. Clearly this research found companies have logistics initially involved at quite different stages of NPD. It would be of value to determine the context and the percent completion that would offer the greatest benefit for logistics involvement.

One of the surprising results from this dissertation research is that Cross-Functional product development (CFPD) did not directly lead to improved product performance. It was not clear why this happened, as much of the NPD literature tends to extol the benefits of CFPD and this discrepancy needs to be further researched.

Another counter intuitive result was the inverse relationship between environmental uncertainty and logistics functional salience. Therefore, future research needs to be conducted to ensure this is not an artifact of this research study but is broadly applicable and logistics does become less salient as environmental uncertainty increases.

CONCLUDING REMARKS

This dissertation studied the relationship between logistics involvement in new product development and improvements in new product development project performance and logistics performance. Both project performance and logistics performance were found to have improved with the inclusion of logistics as a function in a cross-functional integrated new product development approach. In addition this dissertation identified environmental factors led to greater logistics functional salience within the firm.

It is hoped this research will benefit both practitioners and researchers to improve the process of new product development of durable manufactured goods and logistics functional salience within the firm.

In conclusion, this dissertation hopefully will also serve as the beginning of a long and rewarding stream of research concerning the role of logistics in both new product development and product management, both within the firm and within the supply chain.

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APPENDICES

APPENDIX I

MEASURES DEVELOPMENT

List of Companies Interviewed

Automotive Industry	General Motors Saturn Corporation Daimler-Chrysler
Rail Transportation	Burlington Northern Santa
Manufacturer – Retail	Avery Dennison
Logistics	Modus Medial International Ryder Logistics Arvin Merritor
Truck Transportation	Contract Freighters Inland Trucking
Returnable Packaging	Orbis Corporation
Telecommunications	Motorola Zerox
Dot Com	Commerex Inc
Chemical	Basf

Interview Letter

Interview Letter sent before an interview so respondents would be ready for the questions during the interview

Dear

It was good to meet with you at the Supply Chain Forum in Knoxville, Feb. 10-11. Thank you for agreeing to help me with my dissertation.

My committee has approved my dissertation topic to examine Early Logistics Involvement in New Product Development. I would like to arrange a 20-minute telephone interview with you in the next 2 weeks to discuss the role of logistics in New Product Development so that I can develop a survey to send out to the CLM membership.

The five questions I would like to ask are:

1. *Do you know of any examples of new products/services where logistics was NOT involved until the launch and did that affect the project performance and logistics performance?*
2. *Do you know of any examples of new products/services where logistics was involved prior to launch and did that affect project performance and logistics performance?*
3. *What are the factors that would be important to measure in project performance?*
4. *What are the factors that would be important to measure in logistics performance?*
5. *Do you have any contacts that are involved in new product development (who are not in logistics) that I could interview?*

Would you please check your schedule and let me know what would be the best time for the phone interview?

If you feel someone else at your firm or at another company would be an appropriate contact for logistics and new product development, I would appreciate their names so that I can interview them.

Thank you very much for your assistance.

CC: Dr. John T. Mentzer

Interview Scheme

The interview began with asking permission to tape the interview for analysis.

Each respondent was then asked to describe their company briefly, competitive environment, their new product development process and their function in that company.

The purpose of the interview was then conveyed:

to identify measures that could be used to develop a survey to determine if early logistic involvement in new product development would be of benefit.

There were 5 formal questions that were asked during the interview

1. *Do you know of any examples where logistics was not involved in new product development until launch, and did that affect project performance and logistics performance?*

2. *Do you know of any examples where logistics was involved in new product development until launch, and did that affect project performance and logistics performance?*

3. *What are some of the factors that are used to measure new product development project performance?*

4. *What are some of the factors that are used to measure logistics project performance?*

5. *Do you have any contacts that are involved in new product development (who are not in logistics) that I could interview?*

Each interview was slightly different as the direction of the interview was determined by the respondent but an effort was made to ask the above 5 questions in some fashion during the interview. Each participant was reminded that a preliminary survey will be sent for their review.

Interview Summary

Logistics Not Involved Examples

Note: R = respondent and I = interviewer

Some of the anecdotes that were collected during the interview with logistics executives.

R: Fabric softeners I don't know to what extent you're aware of it are about 5% ingredient, and 95% water. So if you freeze it and what happens and I found this out. Am I too long winded here?

I: No, no, no. In fact the more anecdotal it is the greater value it will be.

R: Okay well here's what happened was if you froze this material it became lumpy so what happened was we had a delivery where we apparently followed a trailer into Walmart, and either they had a very bad experience, but they were basically opening up our fabric packages at the tail end of the truck, and essentially opening up, and pouring it you know one out to check the lumpiness of the material.

I: Right.

R: And as a consequence apparently one of these trailers that we shipped into them was in fact subjected to freezing, and they rejected it.

There have been times where vehicles have been uh manufactured or developed shall we say without getting us involved in the tie down location on the vehicle.

I: Uh huh.

R: And when that happens we can lose as much as one vehicle per trailer or two vehicles per haul-, or for railcar as far as the loading capabilities.

I: Right.

R: And that comes at a cost of as much as $200 per vehicle to be left off of that railcar.

This is actually for an application that was originally developed for Mexico. When we looked at all the needs it required, there's lots of small vans that distribute - we looked at the manufacturing processes, the integration of the packaging system, the products to the packaging systems. And we looked at the delivery side of it, but what was not understood the role that the driver plays and the individual vans plan on the distribution logistics of that product.

I: Um-huh.

R: Well it interfaced with the manufacturing side, and it interfaced beautiful with the retail side. The logistics and distribution nobody asked the drivers, and they were the ones that loaded/unloaded, carried, sorted; it was assumed that they would take the system and go with it.

I: Okay.

R: Now on a logistics standpoint at the end of the day it required a significant number of modifications to trucks as well as handling practices. And at the very end of the day the drivers, the delivery folks just refused to make those accommodations.

Wheels okay. There's you know suppliers no doubt close to a manufacturing plant or you know the assembly plant rather in metro Detroit area, but when they go to make the significant purchase of those to support you know a program over three or four or more years they look at what that price would be, and then they go out for competitive pricing. And often times they can find a price better out in you know a supplier out in California or most recently we're finding suppliers in Mexico because of labor rates etc., that they can actually source parts less expensive you know from further away.

I: Right.

R: Well they go ahead and make the business decision to do that. But it's happened in the past, and we're slowly turning that around that they don't consider the logistics ramifications. In other words they'll save a dollar on the price of a wheel, but it costs a dollar and twenty cents to bring you know for transportation to bring the wheel in. And we've seen that happen over the course of years time and time again. In the most recent couple of years we have purchasing actually part of their process is to get logistics involved, and do cost studies to find out hey what if, what if I buy this part for ten dollars and it's shipped from Detroit vs nine dollars shipped from Indiana vs eight dollars shipped from Mexico. So we're involved. But it's only in the recent couple of years that we've had the buying community getting us involved. And before that we just had a lot of mistakes where they'd buy a part cheaper, and then there was a penalty.

I: Okay.

R: Oh and one other thing Zach. Also as we partner with our suppliers sometimes entering these long term agreements, and make commitments to buy parts from them for long terms. And to increase capacity, the manufacturers or our suppliers have to build new plants to support it, support production. And we've seen it happen where they would locate the plant. You know they have opportunities to locate in a centralized area. But they will buy property, and look for a workforce that's maybe a little bit less expensive further away, and the same results happen is the transportation defeats the purpose of you know looking for cheap labor or of a lower cost property. And then logistics eats up all that over the course of years because they've located too far away.

So if you're talking in round numbers and I'm not going to pretend these are the absolute numbers, but early in my career early 90's we had about 12 million finished vehicles, if that were a two thirds, one third sedans vs light trucks we had approximately 8 million sedans, and about 4 million trucks to move.

I: Right.

R: Then you got a shift that I believe came close to 50/50 utilities. All of a sudden we had 2 million additional light vehicles to move which required the bi-levels, and our fleet was patterned very much on the two thirds one third bi-levels and tri's. So all of a sudden when I say all of a sudden over a couple year period the automobile manufacturers who it turns out from the information I had available to me the sales and marketing folks knew that this shift to light vehicles was happening. They had forecasted, they had planned for it. Of course they had production, but it had not been communicated to the logistics people.

I: Correct.

R: And in most cases the logistics folks were getting at best a six month lead time, and more normally from my dialogues with them they were getting 60 to 90 day lead time for demand.

I: Wow.

R: And when you make such a radical shift in round numbers about 2 million vehicles more had to be handled with a very different kind of transportation equipment in logistics distribution process; all of a sudden we had a real shortage of equipment. We had lots of tri-levels, but the decks were too close together to put the light vehicles on.

I: Right.

R: And so the marketing folks, the people that were understanding what was going on and what was going to be produced they had made a shift in the market and logistics people were not part of that equation.

I: Right.

R: More importantly from my prospective because I was a vendor I didn't have a capacity to address that radical of a shift; I couldn't, decks are not moveable so I couldn't just move decks; we're talking about a multi-level flat car is approximately a $100,000 piece of equipment.

I: Oh my goodness.

R: So it's about 23, 24,000 of those in the U.S. fleet at that period of time. For about two market value, replacement value was about 2.3, 2.5 billion dollars. So it was a huge impact and you can't, the only way you could shift from tri to bi is you'd have to rebuild the equipment and although it wouldn't cost quite as much as a new car you basically have to - all these cars have side shields on them full panels to protect the vehicles. The problem with that it has to be stripped off, you'd have to completely basically rebuild the car from the ground up since many of these were relatively older platforms which worked fine in the rail industry. The reality is you'd have to strip the entire everything above the floor of the car off and put whole new platforms on. And so there was a huge shortage, and some very unhappy customers and it was a very difficult situation because they were getting beat on. These were logistics managers at the various automobile companies.

I: Um-huh.

R:R: They were getting beat on because they couldn't get these vehicles into the market, they couldn't get them on the market because we didn't have capacity as a rail industry. And so it became - because there had not been any discussion in lead time on this requirement to have a major shift in the nature and the style of the transportation capacity in logistics there was about two to three years in here where it got real difficult to dialogue and have discussions. Because the system was failing you know it was failing because there hadn't been any advance knowledge given. This major shift from sport utilities or from sedans to sport utilities.

And then you would rachet this down, and that's how you held the cars in place during transit.

I: Um-huh.

R: Well when then went to a monicock construction and the frame basically disappeared or became nominal we tied those cars down, and you put a big heavy duty chain on it then you rachet this chain down we actually ended up bending cars, automobiles.

I: Oh my God.

R: You know the cars weren't ever designed because they didn't have this massive frame, they weren't ever designed to have that kind of pressure put on the under structure.

I: Right.

R: That required us to move very quickly again with a great deal of debate to a chalk system where we had wedge shaped chalks that went before and after each wheel to hold the car in place, and there was a whole lot of issues about should they be tied down you know so they didn't jump up and jump out of the turit chalks, and we had a whole new set of dynamics to learn about the behavior under impact. When you use a chalk system the chain system that had been around for you know forty or fifty years all of a sudden didn't work, and they had changed the body design and still had troops going out there you know racheting these cars down. Gee they look funny they kind of had a sway back to them, and all. And so as another example of fundamental change in the product, an engineering change if you will for weight purposes and etc., that didn't get communicated well to the industry. And the only alternative we had was to chain them down, the chalk system was a fairly expensive cost per car to put a chalk system in place. And it wasn't terribly compatible with having a whole bunch of chains lying on the ground. If you were to move a car or went to move an automobile on a flat car where there were chains and chalks the chains were loose.

I: Okay.

R: So again in that case it wasn't a product shift of research and design from a product shift to a new market segment like the sport utilities it was a basic design in sedans. And that engineering change never got brought over to the rail industry until it started having some very unpleasant experiences again on how you tie these things down.

So you know we see this a lot in the dot com world where they really haven't thought through the transportation and logistics strategy, and real simple pragmatic things like okay what's going to happen when there's a claim; who's responsible for a claim, and how do you want it processed; what happens when there is trailer detention involved at the destination point; who's going to do that, how do you want it handled. The things that we know how to do, and we can offer suggestion that's what ends up happening we offer suggestions on how to deal with these things. But they clearly have not thought about those things. And what that does is it obviously puts pressure on the customer's information technology group as well as the providers.

I: Right.

R: Tremendous pressure on the carrier base. And if you think about the carrier, particularly if they're not one of the big guys.

I: Right.

R: They're the mid tier or lower tier players; these folks are not necessarily the most advanced technologically, and that's not a knock that's just not where they're at.

I: Exactly.

R: Imagine going to that group of carriers and saying look I need pricing, I need the best pricing that you can possibly give because trust me I will have volume.

I: Right.

R: They're going to go back to their transportation you know pricing department, and they're going to get laughed at.

I: Right.

R: And that just puts a huge pressure on the carrier base, and you know it creates some behaviors that aren't necessarily a positive behavior in that some of the providers want to beat up the carrier, you don't want to beat him up so that's a concern, and you have to watch out when you're really, and it's not just the dot coms, but anybody who wants to push the process faster than they should.

I: Right.

R: And then there's internal organization pressure because you know you need to set up this ___, there has to be dedicated resources in order to do that on both sides of the house. And if you're moving too fast and/or you don't have a plan then it's just a fire drill. And the opportunities for failure in a fire drill are very, very high.

I: Exactly.

R: You know the dot com world is just a great example of this problem

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The evolution of the club stores, and now you have this, you know they want this thing rolled off the truck, cut the route, cut a couple of pieces of cardboard, and it's a display at the end of the aisle right?

I: Right.

R: And then so you have that impact, and all of a sudden you get into the warehouse. And then when they're in their in converted form you stock them four high. Now they're in their converted form, and you can stock them one high. Oh where do we pull the extra 35,000 square feet of space from folks. As long it just pops out, especially if it's a product, an aerosol, flammable, combustible air qual you know any and all of those kinds of issues have to be - you got to be prepared for.

The one example was a customer we've worked with for a long time and there was an automotive manufacturing company, and the particular project I remember was a metal stamping. It was a large metal part. It was - if you're familiar with a vehicle manufacturing they make you know the floor pan of the vehicle, eventually the floor of the vehicle is stamped out of·metal.

I: Okay.

R: And they have a front floor pan.

I: Okay.

R: Many times they'll have a center floor pan and they'll have a rear floor pan.

I: Okay.

R: And we got involved with a project late. In other words the design was already done on this particular product.

I: Okay.

R: What happened was the engineering manager, the design engineering manager as the story goes had challenged an engineer to take the center floor pan.

I: Um-huh.

R: And combine it with the rear floor pan so that they could reduce their tools, and try I'm not sure what all the efficiencies were, but the challenge was there. So the engineer designed it so that it could be made into one piece.

I: Okay.

R: You know it probably was part of his you know performance appraisal or whatever, and he did it. Well what happened was that impacted us in the design of the packaging, and you know logistics considerations were in affected greatly. What happened was before when these were two parts you might have gotten sixty or more pieces per container.

I: Um-huh.

R: But if you would have had two different containers well you may have had sixty or so - well let's say you went ahead and redesigned this - this configuration was such that you might only get about twenty pieces per container.

I: Oh my God!

R: Yeah. So and it wasn't a big issue because it was stamped in one location, and the assembly plant was just down the road about a mile or so.

I: Um-huh.

R: That wasn't a huge deal. The other thing though was this vehicle was also being built in Mexico, and so it was coming from the Detroit, Michigan area down to Mexico. And so it was just a huge impact there. And again by the point we were involved it was too late to go back, and make the change. I can't tell you dollars and cents because I don't really know the impact, but you can imagine it was quite huge. I want to say they probably were building about a thousand vehicles a day.

But not including total logistics means usually higher cost and the higher cost in the simplest form would be extra brick mortar to contain it at whatever location it might be. It might just mean logistics was not involved in identifying the shipping requirements coming from a supplier and those shipping requirements might be as simple as pallets can't be the greater height including the pallet of 60 inches.

I: Okay.

R: Who's paying the freight in belt usually the receiver is paying the freight.

I: Right.

R: And if a pallet is great than 60 inches you know one of the most common fundamentals is that you can't double stack in a trailer.

I: Right.

R: Extra cost, more trailers, more gasoline, more wheels on the road.

Logistics Involved Examples

And so you're going to go out and identify a different supplier. It's pretty typical that we would participate, and in fact provide freight studies to the purchasing folks that are making those decision. The reason for that is you know it often isn't cheaper to buy something for instance out of Mexico if you're going to spend a bunch of money getting it here. So having said that to me the area that we struggle with is things that are done quite quickly. Like a supplier for economic reasons or whatever will close a plant in location A and move their tools to location B. And you know there are horror cases out there where our transportation partner sends his truck in there on the next Monday to pick the freight up, and they don't make the part anymore it's made in another city.

They were looking at launching a new product that would be containing bleach.

I: Okay.

R: Realize --------- is a consumer product soap company.

I: Right.

R: And so what they were looking at was to put out this new and improved product. Unfortunately, however, the formulation of the product required not to exceed a certain temperature.

I: Okay.

R: And what happened was it was circulated around in a document form earlier on to the members of logistics at least my boss and he passed it on to me to basically say do you see any problems with this.

I: Right.

R: And so you know that document essentially was the very beginning of what is the concerns.

I: Okay.

R: And what came out of that specific interaction that I had personal experience with was the fact that the formulation needed to be changed because we couldn't guarantee or sustain that the temperature that had specified was an upper limit couldn't be exceeded.

I: Right.

R: We also looked at the idea of could we provide some kind of a monitoring device in the vehicle that would then you know turn color or otherwise identify when the product was in fact subjected to excessive temperatures.

I: Right.

We have to be involved early on in the product development, the vehicle development itself so that we can make sure that the tie downs that are developed on that vehicle uh make it accessible for the haul away carriers to move the vehicles and accessible for the rail carriers to secure the vehicles safely to the railcar and not cause damage.

If we are involved in it we can help maximize the number of vehicles that can safely go onto the haul away trailers and safely go onto the railcars without causing damage, and yet make sure the tolerances in between the vehicles are maintained safely and the vehicles are secured to the railcar.

R: Example of this is the, the ----- that are manufactured out of our Belvedere, Illinois, assembly plant. Maintaining our tolerances and by adding a foam pitch to the front bumpers we are able to still maintain a shipment of 18 vehicles per railcar. Whereas without our involvement it was going to reduce it by 3 vehicles per railcar so we would have only gotten uh 15 vehicles per railcar.

I: And how long did it, I mean, in that particular group, was it 2 years before they launched and you were, you had enough time to give them suggestions?

R: Yes, yes.

I: And, and how exactly did you, you know, what did you change in the design?

R: The change in the design was in working with the design engineers the overall length of the vehicle, by shaving off uh really millimeters and inches we were able to maintain what we needed as far as a safe distance in between vehicles on the railcar. So they identified what they wanted as an overall length. We told them if you do it at that length here's what the cost will be to you. But in order to save dollars here's what we need as our minimum tolerance.

I: Oh, okay. And they actually reduced the design by whatever the length you needed?

R: Yes.

I: Okay. And obviously it was very easy at the early stage, but would have been very difficult when you'd actually gone.

R: Well once the design had been and all of the tooling had been put together for the outside suppliers and manufacturers, the bumpers and the componentry it would have been an astronomical fee of millions of dollars uh that they would have had to do for retooling.

I: Right. Okay. So and that's why you need to be up that far in advance?

R: Absolutely.

And so myself and my team started our relationship with them at the beginning of April. We were originally looking at an approval sometime in the June time frame, and then that was actually pushed back by one month by the request of the FDA, and received approval in July. So essentially about three to three and half months of our involvement. And we did a number of things; we helped with the packaging design of the carton, several things first the label that goes on the bottle.

We helped with designing the carton that the bottle would go into. And then putting that carton into a shipping container, and getting it out into the warehouse. So we had to think through many things as it relates to how many things go in a case, what's the dimensions of the case, what are the implications to the packaging agent, the warehouse third party provider conducting the pick, pack and ship operations. We had only one product to deal with which was a unique experience that many other companies won't have as they look launching products; they have to manage that with everything else that's in their portfolio. But we had the unique opportunity of defining things like the case size, and agreeing upon common standards of dimensions and weights, and those sorts of things so that there was a better commonality of finished product per case. And we could do things like maximizing the cube in And we could do things like maximizing the cube in the warehouse as well as maximizing cube in transportation of the product.

There are things that we were able to do in terms of consistency, and case quantities, and sizes as well as the detailed scheduling of all of the parties involved so that there no mis-cues in handing off responsibilities and activities from one party to the next.

And procurement folks are continuing to find better ways to take cost out of conducting the transaction for product purchases. And so it's imperative I think that they be involved early in that process.

I: Excellent, excellent.

R: Also as it relates to manufacturing of the product, knowing that you've got folks from the materials management production areas involved because clearly there are multiple ways to make a product and there are some ways that are being more cost efficient than others.

I: Right, right.

R:R: Either from a tax advantage standpoint of where you make it or how you make it depending upon what machinery and technology you use to do so.

But still we've recognized that it's important to get involved as much as three, four years ahead of time to help make decisions about sourcing of parts, for instance supply base or in our purchasing people that are you know buying parts for the vehicles. They must realize that the further away the supplier is the more transportation cost there is involved to get the parts in so we help them with sourcing decisions. We work with the people that are designing material handling, the people designing the racks the bring the parts in to make sure that understand that there's a implication of how large they design the rack or maybe how many parts or as we call it the density of the rack when they put it in a rack because it all again translates to increased or decreased transportation costs. So all those are - those are some of the things why we get involved early in the program to make sure the right business decisions are made that will you know positively affect logistics part.

And how we get involved early, and it's worked for us in Toledo, we found a property that was I can't say necessarily equal distance to __ plants. But for the purpose of logistics and the transportation costs involved it was strategically placed based on cost studies of us getting involved early that Toledo and this one certain area near a highway was recognized as the best place to bring this freight from that supplier for the five plants in, and stand it out from there.

I: Okay.

R: Because again because we were involved early, and cost studies were done we minimized the logistics cost.

They realized that they didn't have capacity at their plant that currently provides seats for other -------- vehicles. So they had to build a new plant. And working with our purchasing community, and with logistics they found a place - apparently they could have added on to their current facility or they could have you know put up a place you know within a certain radius of their current facility taking advantage of the workforce, and other synergies. But they decided to move it some seventeen miles closer to the plant cutting the transit miles from 45 miles to something like 38 miles or less than that. I'm sure it was less than that, about 30 miles. And the transportation savings based on the fact that there's twenty-two truckloads a day going from that supplier to the plant.

I: Um-huh.

R: Based on a 259 day production schedule a year. It was millions of dollars of savings.

And that meant that there were some fairly major pieces that came in from offshore. One of the pieces that was coming in was the wing spar.

I: Okay.

R: It's that large structure that goes across the ___ lodge and out into each wing it's kind of a fundamental frame of the airplane that everything is built around. Those were very, very large I've forgotten the exact dimensions, but they were like 20 x 40.

I: My goodness.

R: So they were much larger then would fit on a normal transportation mode of any kind.

I: Right.

R: He had a pretty interesting team that was looking at all aspects of the business. And one of the things that they knew or they determined was that these wing spars were coming in from their Asian realm. I believe Japan but I'm not sure. Again probably could be found out fairly readily. But the spars would come into a port, and that size piece of equipment, and my numbers are approximately were way too big for any kind of transportation. You know to get it from the port up to Everett which isn't - the Boeing facility sits on top of a hill in Everett and it's not terribly far from the port, but you don't take 20 x 40 through city street.

I: Right.

R: And we had - they were coming in a very large container. I want to say it was about 20 x 40 container. And that wouldn't clear -------'s signals and switch stands, etc., etc. So they let us know in this case in advance that this was coming.

I: Um-huh.

R:R: Several years in advance, a couple of years in advance. So what we did in that case is we conjunction with Boeing moved all of our signal structure, widened the track centers so that these parts could come into the port of Everett and would have full clearance on the railroad; it was only a few miles. So it would have full clearance by all of our structures, whenever you pull bridges etc., etc., so that we could take up to the Everett facility. In that case you know this was the style or the decision to use offshore parts to make it a global airplane beginning with the air box etc.

I: Right.

R: And so it was a given that they had to bring these parts in. The question was logistically sitting in that big a box 20 x 40 foot container on the deck of a ship wasn't a big deal.

I: Right.

R: They could take that fairly readily in place of several other containers. The problem was the land site, and so in that case Boeing worked with our people, our engineers. They removed everything so that when those containers started coming in we put them on a standard flat car, but of course they had tremendous overhang.

I: Right.

R: And there was no problem. We had to you know coordinate it with other trains; of course couldn't have other trains passing when this particular move came through. But we hadn't moved all of the signals and the switch stands, and all of the other track site devices we wouldn't have been able to - we would have been in a real bind. It would have been at the port, but literally I guess you could have helicoptered them up if you find big enough helicopter. But in that case the process for building that new aircraft very much incorporated the logistics requirements of the oversized parts that were coming in.

They are actually doing a build-up with us, and they're saying okay now out of all of the bill of materials to build this vehicle here are my sourcing requirements; here are the vendors, here are the sourcing requirements, here are the container requirements, here are return ratios of the containers. We then in our logistics group are working collaboratively with ------ to build up the routes, and the carrier selection within the routes.

I: Okay.

R: Now think about the power of that you know you can commit because a dealt is a year.

I: Right.

R: For any new model vehicle so you know for one year what's going to take place. And you can go to the carrier community, you can build routes, you can do mode conversions. As a matter of fact one of the things that our people did is we saw a great opportunity on this specific lane to use road railer.

I: Okay.

R: And ------- and had not used the road railer. As a matter of fact they weren't real keen about using road railer on this one lane.

I: Right.

R: The cost savings were substantial so we figured out a way to work with the provider to say look you must guarantee to me the capacity and the service level or guess what I'm going to plan B and you're off the route. And there won't be any second chances. Well it was a great success.

I: Excellent.

R: Because the carrier was afforded an opportunity that he would not have gotten.

I: Right.

R: -------- saved money as a result and it's a win win for everybody. So that's a good example of you know somebody who working with us well in advance and say I know you know here's my forecast, here's my ___ forecast.

I: Right.

R: And you can changes. Now I did some quick discussions with the Chryslers guys who do this on what they think the cost advantage is by pre-planning.

I:I: Right.

R: They believe that just like the pre-plan alone it's about a 5% improvement.

I: Wow!

R: And I said okay look at the converse; what if they gave you no lead time and it was a fire drill that some people put you through what would be the premium. And they said look you know if you had to do this with no lead time, and no build up we estimate that it's about a 20% expedite premium.

So that's why we got this phone call. I would have liked to have seen us have the phone call way before this. But we should have this phone call. Well when it was said and done it was a real good thing for us because we learned a lot about the whole process, but here's an example of things that went on. And that was say by the way you know if you go to Reno you're going to save $400,000 a year. This was all base - where did you get this information. From the library. From the library. Hey that's pretty good. I liked that one. Eye ya, ya come on guys. You know it took this real basic logic like you know Reno is further away from San Jo, Missouri. So if somebody charges you a buck a mile to bring the truck out here then it's logical that since it's 275 miles further away from Reno than Reno is that it's going to be cheaper to take the truckload in there. Wrong, wrong. It's more expensive, $200 to $300.

I: Wow!

R: Yeah because they can't get out of there.

I: Okay.

R: Anybody that goes in there they can't get the trailers out of there, they have to reload them and reposition them. You know it's kind of like the rate for going there is a buck forty a mile, and the rate for coming here is a buck five a mile.

I: Right.

R: And so they just had not done their homework the way they needed to do their homework. But in getting involved in that, in that whole process it was something that you know we were able to then help them with the rest of the system where they redesigned the network from about thirty-five warehouses down to five.

Project Performance Factors

My assumption is that first obviously they've got cost targets.

I: Okay.

R: Okay that cost target is going to include really piece price and freight.

Did we increase our market share, did we you know did we have to pour a bunch of extra money into marketing that or whatever I'm sure those measures are out there.

I: Okay.

R: You know there will be some pretty obvious measures on quality that we'll throw in there too that would be out there you know initial quality; you know we would track pretty closely J.D. Powers for instance.

I: Right, right.

The ultimate cost of the product, we are measured by the outbound transportation cost.

I: Okay.

R: And that is a component of the overall cost of the vehicle.

I: Okay.

R: And it's also a component that's listed on the Monroney label, the sticker that says destination charge.

Okay. And was there a fourth factor or was that four right there. Time to market, margin per press hour, and return on assets, market share and conversion rate.

I can rattle it off real quickly.

I: Okay good then I've got in on tape.

R: A background of the issue.

I: Okay.

R: A market analysis.

I: Okay.

R: The value proposition.

I: Okay.

R: The surface definition.

I: Okay.

R: Financial plan to include a profit and loss, the cost. And then you would generally find some appendices like my _____ business includes an overview of the Internet industry, specific project plans, and then order process since it's a slightly different order process than the norm.

I: Okay.

R: So stuff like that.

We looked at performance measures in terms of how fast were we getting our bills out, how accurately were they flowing out. But the measurement with the successful of that project was if we could decrease the number of times we handled the paperwork.

Logistics Performance Factors

We then would use typical measures you know to assess the success of our transportation system you know we'd use some measure of utilization of equipment. Our inbound all comes in trailers so we use some measure to try and measure the cubulization of the trailers.

Internally there are some other measures that are not necessarily related to location. You know we'd measure the supplier, the transportation partner, on time performance, you know the quality of their services, the freight damaged or not. There's some measures like that that we tried. And really their measures that they measure themselves, and then report to us.

So there are those kinds of measures; you know on time performance is you know have they shown up the supplier on time, and then rather obviously are they getting to our docks on time.

I think what we were also looking at was product damage.

I: Product damage okay.

R: But we'd want to basically not over hang and under hang the pallet; you'd want to incurve someone from lifting a box over their head and possibly drop it.

For 15 years I've been involved in the vehicle logistics process here as far as shipment of vehicles out of the plant to destination dealers with the 3 key un measurements. And those measurements are quality, that is the number of vehicles damaged en route to the dealer from the plant; the cost, what does it really cost for a vehicle to move from point A to point Z; and the transit time - how long does it take for a vehicle to go from the end of the assembly line till it reaches the dealer?

So those are the three key measures that we look at from here. Um and cost understand is the, not just what it takes to move a vehicle from point A to point B, but also part of that is the transit time because we reimburse the dealers the interest that they have uh, that they have coming to them from the amount invoiced for the vehicle.

I: Oh, I see.

R: So everyday that we save is a what we consider an average of $6 per vehicle per day.

Well project performance is not only the dollars that are saved, not only the cost savings in making an efficient vehicle shipment, but also the quality numbers as far as making a damage free shipment that you can design to a standard that keeps your quality at a higher level and at the same time you're also designing to maximize the efficient utilization of your equipment and get the most out of it.

I: Right. Okay. Uh typically I would view that almost as logistics performance because you're thinking about uh quality and everything, and I might be sort of misunderstanding it. Do you also look at things like on time delivery? Yeah, your transit time.

R: Absolutely.

I: Right?

R: That, that's one of our component measurements, yes.

I: Right. Okay. Um any others on that thing? You gave me three at the beginning. You had cost, transit time and quality.

R: Yep, those are the three. And and we've, we talked about cost, we talked about the quality as far as the vehicle's getting to the customer undamaged so that the dealer doesn't have to do any kind of repairs to the vehicles and delay giving it to the customer because of repairs that occur in transit.

I: Right. Okay.

R: And then it's the transit time and the, yeah, those are the three.

Uh I guess uh, you know, from, from that perspective uh, you know, you're reduction in the shipping costs. You know, that would be the biggest one. And your timeliness of being able to deliver. In other words, if uh, if you're capacity of your plant, if you want to jump up capacity you've got to look at logistics and how it ties into that. And if you're going to, can you, can you easily step up by a 30% capacity by just simply rerouting some of the trucks or is it, you know, logistics makes it much more of a difficult piece to, to deal with.

It might be measured, but I wouldn't put a lot of value in it in the first sixty days. Somebody needs to track the inventory investment, position of inventory.

I: Um-huh.

R:	Generally what will happen in a product launch is nobody wants to be out of stock when you're running a deal on a new product.

If I'm understanding the question correctly we look at ability to - safety has been a core element on the logistics of products and we tend to ship a lot of air.

I:	Um-huh.

R:	And so the ability to density product and do it in a safe way, a stack, stack integrity convince ability for shipment to minimize the freight cost associated with getting our products to our customers. And then also for our customers in their application one of the big justification points is around the logistics part; how efficiently and how cost effectively can they return the empty product back to fill it again, and then get it back out.

And then time, liability, shipment time, time promised that type of thing is critical.

Is first of all for logistics I'm sure that their objective, their goal what they live and breath to do down there for is deliver a damage free vehicle that's logistics goal.

I:	Right.

And that's Inbound Transportation, and that's the cost.

I:	Okay.

R: That's how much it costs when all is said and done, and at the end of every month you have - the people that pay freight bills for all the freight coming in, and divide it by the number of vehicles you make that is our measurable. And that's what we strive to hold the cost down. And first of all in the four years ahead of time determine what the cost will be.

I: Um-huh.

R: And then when we've hit volume production make sure that we're at that part of it.

I: Wow!

R: So it's inbound transportation cost.

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some of the things that were important to us were understanding the cycle times as it related to the manufacture of the product during a period of product launch.

I: Okay.

R: Now it's sort of like getting prepped for the holidays. If you miss Christmas you've just missed it.

I: Right exactly.

R: There's a lot of monies, and a lot of sweat equity created across multiple functions in an organization be it marketing and sales to get everything prepped for the launch.

I: Right.

R: You know one of the things is order cycle time, manufacturing cycle time, the order cycle time, the fulfillment step of how do you do the pick, pack it, and ship, what things can you figure out to take time out of the activity. So any of the performance measurements that are focused on the time element, the speed to market are imperative. Some of the other metrics might be around the area of engineering changes, and the creation of the documentation that would go along with the product. So in the pharmaceutical industry a lot of the label generation, physician insert or the patient insert; these are things that can be created upstream of FDA approval, but cannot be taken to press prior to approval. And there's a lot of proofreading and clarification for accuracy that go on before it goes into production.

I: Right.

R: So any measurement that relates to the number of changes to packaging material, and again measuring the dimension of time of being able to compress that as much as possible.

R: Which helps people focus their efforts. If they're booking a lot of orders, but not invoicing a lot of orders it may lead you to believe, it may indicate to you that there's a problem in creating the invoices or getting product out the door.

Okay.

R: The first one is service performance.

I: Okay.

R: And that would include things like on-time pick up, on-time delivery, equipment availability. You know carrier related, our transportation type metrics.

I: Okay.

R: You've got to measure to make sure that you're delivering value from a service prospective.

I: Right.

R: And then the other one is cost.

I: Okay.

R: And cost I really break up into two different, two different categories. The first is I call it a base line.

I: Okay.

R: So base line is basically in a clumpifiable manner I spent X dollars last year, how many dollars am I spending this year it's got to be improved.

I: Okay.

R : If you want to call it a base line or freight rate base or whatever, but that's a quantifiable number.

I: Okay.

R: The second one which is a little bit more difficult but actually I think more valuable is project base savings. And project base savings would be something like oh - I'll give you an example a big paper company.

I: Okay.

R: That we worked with had fourteen different physical locations in a campus for trailers.

I: Okay.

R:R: We did a time study, an engineering time study, an analysis - we did use of simulation techniques, came back with a recommendation on who should be what when, and also reconfiguring the fourteen ___ to put some control in.

I: Um-huh.

R: You can't necessarily quantify everything. So you know what we did is take these recommendations and install these processes, and solve this software; these are the savings you would enjoy as a result.

I: Super.

R: I call that kind of thing a project base savings.

I:I: Okay.

R: Specific, the final project.

I: Okay. Good distinction. That's subtle, but yeah I could see how that's of more value.

R: Sure. And you know you can do it with all kinds of - I'll give you a very simple one.

I: Right.

R: Deal with inventory problems that way. All kinds of different things that aren't going to show up in a freight bill.

I would the on time delivery and percent filled, first shipment.

I: Um-huh.

R: Would be additional key measures the percent filled for shipment.

READABILITY SURVEY

GENERAL INSTRUCTIONS

I am interested in your general perception of the new product development process in your firm for a specific project. Therefore as you are filling out this survey, please think of the most **recent** new product project, that you have been involved in, that has been in the market for at least a year.

Section 1 - New Product Project Description

1. This new product can best be categorized as: (Please check one only)

a)_____New to the World b)_____New to the firm c)_____Major Revision

d)_____Minor Revision e)_____Repositioning (New Market) f)_____ Cost Reduction

2. In terms of innovation this product can be characterized as: (Please check one only)

a)_____Radical Innovation - the market is unfamiliar with the product class and technology

b)_____Routine Innovation - the market is familiar with the product class but the technology is new

c)_____Market Modification - the technology is well known but users are unfamiliar with the product

d)_____Product Modification - neither the market nor the technology is new

3. Please rate this product's degree of improvement over existing products.	Minor Improvement 1	2	3	4	5	Radical Break-through 6	7
4. The new product development process as a whole could be best characterized as...	Informal (ad-hoc) 1	2	3	4	5	6	Formal 7
5. To go from one stage of development to the next required...	Informal approval 1	2	3	4	5	6	Documented Approval 7
6. To what extent did this new product meet its...	Fell Far Short						Far Exceeded
a)...profit objectives	1	2	3	4	5	6	7
b)...budget objectives	1	2	3	4	5	6	7
c)...market share objectives	1	2	3	4	5	6	7
d)...customer satisfaction objectives	1	2	3	4	5	6	7
e)...competitive advantage objectives	1	2	3	4	5	6	7
f)...speed to market objectives	1	2	3	4	5	6	7
g)...quality or performance objectives	1	2	3	4	5	6	7
7. The tasks for the product development project were	Not Functionally Related 1	2	3	4	5	Functionally Related 6	7

Section 2 – Logistics Involvement

8. When did Logistics/Distribution first become involved in the new product development project (from 0% meaning just started to 100% meaning completion)?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Just Started										Completion

If logistics was not directly involved in the new product development project until 100% completion please skip question 9 - 11 and go to question 12 below:

9. In this project team, logistics during...	Not Involved						Highly Involved
a) Idea Generation was...	1	2	3	4	5	6	7
b) Idea Screening was...	1	2	3	4	5	6	7
c) Market Analysis was...	1	2	3	4	5	6	7
d) Product Development was...	1	2	3	4	5	6	7
e) Product Testing was...	1	2	3	4	5	6	7
f) Product Launch was...	1	2	3	4	5	6	7

10. In this project team, the level of logistics...	Low						High
a) creativity was...	1	2	3	4	5	6	7
b) autonomous contribution was...	1	2	3	4	5	6	7
c) ideas generated were...	1	2	3	4	5	6	7
d) ideas that were implemented were...	1	2	3	4	5	6	7

11. In this project team, logistics...	Strongly Disagree						Strongly Agree
a)...was influential	1	2	3	4	5	6	7
b)...directly impacted the outcome	1	2	3	4	5	6	7
c)...was highly committed	1	2	3	4	5	6	7
d)...was highly cooperative	1	2	3	4	5	6	7
e)was highly valued by other team members	1	2	3	4	5	6	7

12. Compared to other new product projects developed within your firm, this product's...	Far Below Average						Far Above Average
a) logistics/distribution costs were...	1	2	3	4	5	6	7
b) order fill rate was...	1	2	3	4	5	6	7
c) on time delivery was...	1	2	3	4	5	6	7
d) damage free delivery was...	1	2	3	4	5	6	7
e) equipment utilization was...	1	2	3	4	5	6	7
f) transit time was...	1	2	3	4	5	6	7

Section 3 – Logistics/Distribution Description

13. The logistics/distribution department is an important department in your firm	Strongly Agree						Strongly Disagree
	1	2	3	4	5	6	7

14. The logistics department has become important in the firm in terms of...	Strongly Disagree						Strongly Agree
a) visibility within the firm	1	2	3	4	5	6	7
b) degree of access to top management	1	2	3	4	5	6	7
c) degree of decision-making influence	1	2	3	4	5	6	7

15. In your market, to what extent does logistics provide/contribute...	Low						High
a) a cost advantage	1	2	3	4	5	6	7
b) a quality advantage	1	2	3	4	5	6	7
c) a competitive advantage	1	2	3	4	5	6	7

Section 4 - Industry Description

16. In your industry...	Strongly Disagree						Strongly Agree
a) firms rarely change their marketing practices	1	2	3	4	5	6	7
b) the rate of product obsolescence is slow	1	2	3	4	5	6	7
c) the rate of technology obsolescence is slow	1	2	3	4	5	6	7
d) actions of competitors are easy to predict	1	2	3	4	5	6	7
e) demand is easy to forecast	1	2	3	4	5	6	7

17. How extensively are the following used in your industry:	Not Used						Greatly Used
a) Just-In-Time	1	2	3	4	5	6	7
b) Vendor Managed Inventory	1	2	3	4	5	6	7
c) Automatic/Continuous Replenishment	1	2	3	4	5	6	7
d) Quick Response	1	2	3	4	5	6	7
e) Efficient Consumer Response	1	2	3	4	5	6	7
f) Collaborative Forecasting and Planning	1	2	3	4	5	6	7
g) Postponement	1	2	3	4	5	6	7

18. In your industry...	Strongly Disagree						Strongly Agree
a) global sourcing is the norm	1	2	3	4	5	6	7
b) global competition is the norm	1	2	3	4	5	6	7
c) global manufacturing is the norm	1	2	3	4	5	6	7

19. How extensively are the following technologies used in your industry:	Not Used						Greatly Used
a) Electronic Data Interchange	1	2	3	4	5	6	7
b) Internet	1	2	3	4	5	6	7
c) E-Commerce	1	2	3	4	5	6	7
d) Real Time Product Tracking	1	2	3	4	5	6	7
e) Supply Chain Information systems	1	2	3	4	5	6	7
f) Enterprise Resource Planning (ERP)	1	2	3	4	5	6	7
g) Advance Planning and Scheduling Systems	1	2	3	4	5	6	7

Section 5 - Respondent/Firm Description

21. What is your title?____

22. What is your department?____

23. The primary industry in which your firm competes:_____________________________________

24. Approximately how many new product projects have you been involved in your career?______________

25. Indicate the size of your firm/business by the approximate number of employees.

a)___< 100 b)___101-250 c)___251-500 d)___501-1000 e)___1001-5000 f)___5001-10,000 g)___> 10,000

26. Which of the following best describes your firm's role in the supply chain?

a)____Raw Material Producer b)____Supplier c)____Manufacturer d)____Wholesaler e)____Distributor

f)____Retailer g) ____Other (Describe)____

27. Approximately, what is your company's annual sales?

a)____< $1 Million b)____$1-$9 Million c)____$10-$99 Million d)____$100-999 Million e)___> $1 Billion

Thank you again for your time and assistance.
(Don't forget to include your business card
if you would like to enter the drawing or a copy of the executive summary from this study.)

Upon completion, please fax to (865) 974-3889

or mail to

Zach Zacharia, The University of Tennessee

Department of Marketing, Logistics and Transportation

Suite 309 Conference Center Building, Knoxville, TN 37996-4133

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SURVEY SOURCES

Construct	Source	Adopted Modified	QUESTION
	Academic Reviewers		1. How many years has this product been in the marketplace?
Innovation level	Academic Reviewers		2. In comparison to existing products in the firm this product's degree of improvement is...
Innovation Level	Hall (1991)	Adopt	3. In terms of innovation this product can best be characterized as:
Market Newness	Meyers & Tucker (1989)	Modify	4. To what extent was the market familiar with this product class?
Technology Newness	Meyers & Tucker (1989)	Modify	5. To what extent was the new product based on existing technology?
6. To what extent did this new product meet its...			
Product Performance	Rochford (1992)	Adopt	a)...profit objectives
Product Performance	Rochford (1992)	Adopt	b)...budget objectives
Product Performance	Griffin & Page (1996)	Adopt	c)...market share objectives
Product Performance	Academic Reviewers		d)...customer satisfaction objectives
Product Performance	Griffin & Page (1996)	Modify	e)...competitive advantage objectives
Product Performance	Griffin & Page (1996)	Adopt	f)...speed to market objectives
Product Performance	Griffin & Page (1996)	Adopt	g)...quality or performance objectives
7. During new product development departments within the firm...			
Cross-Functional Integration	Kahn & Mentzer (1998)	Adopt	a) are encouraged to work together
Cross-Functional Integration	Kahn & Mentzer (1998)	Adopt	b) share information and provide input
Cross-Functional Integration	Kahn & Mentzer (1998)	Adopt	c) share resources
Cross-Functional Integration	Kahn & Mentzer (1998)	Adopt	d) achieve goals collectively

Cross-Functional Integration	Kahn & Mentzer (1998)	Adopt	e) informally work together as a team
Timing	Birou & Fawcett (1994) McGinnis & Vallopra (1999)		8. When did Logistics/Distribution first become involved in the new product development project (from 0% meaning just started to 100% meaning completion)?
9. In this project team, logistics during...			
Magnitude	McGinnis & Vallopra (1999)	Mod	a) Idea Generation was...
Magnitude	Gupta, Raj and Wilemon (1986)	Mod	b) Idea Screening was...
Magnitude	Gupta, Raj and Wilemon (1986)	Mod	c) Market Analysis was...
Magnitude	Gupta, Raj and Wilemon (1986)	Mod	d) Product Development was...
Magnitude	Gupta, Raj and Wilemon (1986)	Mod	e) Product Testing was...
Magnitude	Gupta, Raj and Wilemon (1986)	Mod	f) Product Launch was...
10. Once logistics is involved, the level of logistics...			
Quality	Birou (1994)	Mod	a) creativity was...
Quality	Birou (1994)	Mod	b) autonomous contribution was...
Quality	Birou (1994)	Mod	c) ideas generated (number of ideas) were...
Quality	Birou (1994)	Mod	d) ideas that were implemented were...
11. In this project team, logistics...			
Quality	Birou (1994)	Mod	a)...was influential
Quality	Birou (1994)	Mod	b)...directly impacted the outcome
Relationship	Birou (1994)	Mod	c)...was highly committed
Relationship	Birou (1994)	Mod	d)...was highly cooperative
Relationship	Academic Reviewers		e)...was highly valued by other team members
12.In your opinion, compared to other new products developed within your firm, this product's...			
Logistics Performance	Chow, Heaver & Henriksson (1994)	Adopt	a) logistics/distribution costs were...
Logistics Performance	Chow, Heaver & Henriksson (1994)	Mod	b) orders that were filled as requested...

Logistics Performance	Chow, Heaver & Henriksson (1994)	Adopt	c) on time delivery was...
Logistics Performance	Executives		d) number of damage free deliveries was...
Logistics Performance	Executives		e) utilization of transportation equipment was...
Logistics Performance	Executives		f) transit time to customer was...
Logistics Functional Salience	Academic Reviewers		13. The logistics/distribution department is an important department in your firm
14. The logistics department has become important in the firm in terms of...			
Logistics Functional Salience	Forker - Ruch and Hershauer (1999)	Mod	a) visibility within the firm
Logistics Functional Salience	Forker - Ruch and Hershauer (1999)	Mod	b) degree of access to top management
Logistics Functional Salience	Forker - Ruch and Hershauer (1999)	Mod	c) degree of decision-making influence
Logistics Functional Salience	McGinnis & Vallopra (1999)	Mod	d) a cost advantage
Logistics Functional Salience	McGinnis & Vallopra (1999)	Mod	e) a service quality advantage
Logistics Functional Salience	McGinnis & Vallopra (1999)	Mod	f) a competitive advantage
Logistics Functional Salience	Academic Reviewers		g) a profitability advantage
15. In your industry...			
Environment Uncertainty	Miller & Droge, (1986), Birou (1994), Vickery Calantone, & Droge (1999)	Adopt	a) firms rarely change their marketing practices

Environment Uncertainty	Miller & Droge, (1986), Birou (1994), Vickery Calantone, & Droge (1999)	Adopt	b) the rate of product obsolescence is slow
Environment Uncertainty	Miller & Droge, (1986), Birou (1994), Vickery Calantone, & Droge (1999)	Adopt	c) the rate of technology obsolescence is slow
Environment Uncertainty	Miller & Droge, (1986), Birou (1994), Vickery Calantone, & Droge (1999)	Adopt	d) actions of competitors are easy to predict
Environment Uncertainty	Miller & Droge, (1986), Birou (1994), Vickery Calantone, & Droge (1999)	Adopt	e) demand is easy to forecast
16. How extensively are the following used in your industry:			
Time & Quality Based Competition	Mentzer (1999)	Mod	a) Just-In-Time
Time & Quality Based Competition	Mentzer (1999)	Mod	b) Vendor Managed Inventory
Time & Quality Based Competition	Ellinger, Taylor and Daugherty (1999)	Mod	c) Automatic/Continuous Replenishment
Time & Quality Based Competition	Mentzer (1999)	Mod	d) Quick Response
Time & Quality Based Competition	Zacharia (2000)	Mod	e) Efficient Consumer Response
Time & Quality Based Competition	Executives		f) CFPR
17. In your industry…			
Global Factors	Executives		a) global sourcing is the norm
Global Factors	Executives		b) global competition is the norm
Global Factors	Executives		c) global manufacturing is the norm

18. How extensively are the following technologies used in your industry:			
Improving Information Technology	Executives		a) Electronic Data Interchange
Improving Information Technology	Executives		b) Internet
Improving Information Technology	Executives		c) E-Commerce
Improving Information Technology	Executives		d) Real Time Product Tracking
Improving Information Technology	Executives		e) Supply Chain Information systems
Improving Information Technology	Executives		f) Enterprise Resource Planning (ERP)
Improving Information Technology	Executives		g) Advance Planning and Scheduling Systems
Demographics			19. What is your title?
Demographics			20. What is your department?
Demographics			21. The primary industry in which your firm competes:
Demographics			22. Approximately how many new product projects have you been involved in your career?
	Griffin & Page (1996)		23. In your opinion, what percent of your company's profits come from products less than 5 years old ?
Demographics			24. Indicate the size of your company by the approximate number of employees.
Demographics			25. Approximately, what is your company's annual sales?

APPENDIX II

PRE-TEST

PRE-TEST SURVEY

GENERAL INSTRUCTIONS

I am interested in your general perception of the new product development process in your firm for a specific project. Therefore as you are filling out this survey, please think of the most **recent,** new product project that you have been involved in, that has been in the market for at least a year.

Section 1 - New Product Project Description

1. Approximately how many years has this product been in the marketplace? ___________years

2. In comparison to existing products in the firm this product's degree of improvement is...	Minor Improvement						Radical Break-through
	1	2	3	4	5	6	7
3. To what extent was the company familiar with the market for this product class?	Highly Familiar						Not Familiar
	1	2	3	4	5	6	7
4. To what extent was the new product based new on existing technology?	Known Technology						Developing, Technology
	1	2	3	4	5	6	7
5. To what extent did this new product meet its....	Fell Far Short						Far Exceeded
a) profit objectives	1	2	3	4	5	6	7
b) budget objectives	1	2	3	4	5	6	7
c) market share objectives	1	2	3	4	5	6	7
d) customer satisfaction objectives	1	2	3	4	5	6	7
e) competitive advantage objectives	1	2	3	4	5	6	7
f) speed to market objectives	1	2	3	4	5	6	7
g) quality or performance objectives	1	2	3	4	5	6	7
6. During new product development departments within the firm...	Strongly Disagree						Strongly Agree
a) are encouraged to work together	1	2	3	4	5	6	7
b) share information and provide input	1	2	3	4	5	6	7
c) share resources	1	2	3	4	5	6	7
d) achieve goals collectively	1	2	3	4	5	6	7
e) informally work together as a team	1	2	3	4	5	6	7

Section 2 - Logistics Involvement

7. When did Logistics/Distribution first become involved in the new product development project (from just started to 100% completed)?

0% Complete			50% Complete			100% Complete
1	2	3	4	5	6	7

If logistics was not directly involved in the new product development project until 100% complete, please skip question 8 - 10 and go to question 11; otherwise please continue:

8. In this project team, logistics during...	Not Involved						Highly Involved
a) Idea Generation was...	1	2	3	4	5	6	7
b) Idea Screening was...	1	2	3	4	5	6	7
c) Market Analysis was...	1	2	3	4	5	6	7
d) Product Development was...	1	2	3	4	5	6	7
e) Product Testing was...	1	2	3	4	5	6	7
f) Product Launch was...	1	2	3	4	5	6	7

9. Once logistics became involved, the level of logistics

	Low						High
a) creativity was...	1	2	3	4	5	6	7
b) independent contribution was...	1	2	3	4	5	6	7
c) ideas generated (number of ideas) were...	1	2	3	4	5	6	7
d) ideas that were implemented were...	1	2	3	4	5	6	7

10. In this project team, logistics...	Strongly Disagree						Strongly Agree
a)...was influential	1	2	3	4	5	6	7
b)...directly impacted the outcome	1	2	3	4	5	6	7
c)...was highly committed	1	2	3	4	5	6	7
d)...was highly cooperative	1	2	3	4	5	6	7
e)...was highly valued by other team members	1	2	3	4	5	6	7

11. In your opinion, compared to other new products developed within your firm, this product's..	Far Below Average						Far Above Average
a) logistics/distribution costs were...	1	2	3	4	5	6	7
b) orders that were filled as requested were...	1	2	3	4	5	6	7
c) on time delivery was...	1	2	3	4	5	6	7
d) number of damage free deliveries was...	1	2	3	4	5	6	7
e) utilization of transportation equipment was...	1	2	3	4	5	6	7
f) transit time to customer was...	1	2	3	4	5	6	7

Section 3 - Logistics/Distribution Description

12. The logistics/distribution department is an important department in your firm	Strongly Disagree						Strongly Agree
	1	2	3	4	5	6	7

13. The logistics department has become important in the firm in terms of...	Strongly Disagree						Strongly Agree
a) visibility within the firm	1	2	3	4	5	6	7
b) degree of access to top management	1	2	3	4	5	6	7
c) degree of decision-making influence	1	2	3	4	5	6	7
d) a cost advantage	1	2	3	4	5	6	7
e) a service quality advantage	1	2	3	4	5	6	7
f) a competitive advantage	1	2	3	4	5	6	7
g) a profitability advantage	1	2	3	4	5	6	7

Section 4 - Industry Description

14. In your industry...	Strongly Disagree						Strongly Agree
a) firms rarely change their marketing practices	1	2	3	4	5	6	7
b) the rate of product obsolescence is slow	1	2	3	4	5	6	7
c) the rate of technology obsolescence is slow	1	2	3	4	5	6	7
d) actions of competitors are easy to predict	1	2	3	4	5	6	7
e) demand is easy to forecast	1	2	3	4	5	6	7

15. How extensively are the following used in your industry:	Not Used						Greatly Used
a) Just-In-Time	1	2	3	4	5	6	7
b) Vendor Managed Inventory	1	2	3	4	5	6	7
c) Automatic/Continuous Replenishment	1	2	3	4	5	6	7
d) Quick Response	1	2	3	4	5	6	7
e) Efficient Consumer Response	1	2	3	4	5	6	7
f) CFPR	1	2	3	4	5	6	7

16. In your industry...	Strongly Disagree						Strongly Agree
a) global sourcing is the norm	1	2	3	4	5	6	7
b) global competition is the norm	1	2	3	4	5	6	7
c) global manufacturing is the norm	1	2	3	4	5	6	7

17. How extensively are the following technologies used in your industry for business:

	Not Used						Greatly Used
a) Electronic Data Interchange	1	2	3	4	5	6	7
b) Internet	1	2	3	4	5	6	7
c) E-Commerce	1	2	3	4	5	6	7
d) Real Time Product Tracking	1	2	3	4	5	6	7
e) Supply Chain Information systems	1	2	3	4	5	6	7
f) Enterprise Resource Planning (ERP)	1	2	3	4	5	6	7
g) Advance Planning and Scheduling Systems	1	2	3	4	5	6	7

Section 5 - Respondent/Firm Description

18. What is your title? ____

19. What is your department? ___Marketing ___R&D ___Manufacturing ___Logistics ___New Products

___Sales ___Finance ___Other (Describe)______________________________

20. Approximately how many new product projects have you been involved in your career? ___________

21. The primary industry in which your firm competes:

____Food/Beverages/Tobacco ____Chemicals ___Pharmaceuticals/health and beauty aids

___Electronics/computers ___Transportation/motor equipment ___Metals/minerals/petroleum/rubber

____Building materials ___Other (Please describe) ______________________________

22.In your opinion, what percent of your company's profits come from products less than 5 years old? _____%

23. The approximate age of the company __<2years __2-5years __6-10years __11-15years __>16years

24. Indicate the size of your company worldwide by the approximate number of employees.

a)__<100 b)__101-500 c)__501-1000 d)__1001-5000 e)__5001-10,000 f)__10,001-50,000 g)__>50,000

25. Approximately, what is your company's worldwide annual sales?

a)___<$10 Million b)____$11-$99 Million c)____$100-$999 Million d)____$1-5 Billion e)___>$6 Billion

Thank you again for your time and assistance.
(Don't forget to include your business card if you would like
to receive a copy of the executive summary and enter the drawing for 3 palm pilots.)

Upon completion, please fax to (865) 974-3889 or mail to

Zach Zacharia, The University of Tennessee,

Department of Marketing, Logistics and Transportation, Suite 309 Conference Center Building,

Knoxville, TN 37996-4133, E-mail zacharia@utk.edu, Phone (865) 974-4625, Fax (865) 974-3889

TELEPHONE PROTOCOL

Hi *<Title>* *<Last Name>*

My name is _____________.

I am calling on behalf of Dr. Tom Mentzer and Zach Zacharia, his Ph. D. student from the University of Tennessee, to ask if we could send you a 4 page survey on new product development in manufacturing companies.

The survey should take about 12 minutes to complete and is aimed at people who have direct experience with new product development in your firm. We are hoping the information from the survey will provide valuable information on the degree of logistics impact or lack of impact in new product development.

Are you familiar with the new product process within your firm?

If they say yes then ask:
Would you prefer that we fax or mail the survey to you ?

If they say no –
Is there someone else in your company who would be able to fill out this survey?
Get name and number of the suggested person. Hang up and immediately call the suggested person saying the name of the person who recommended to call .

Please return the survey by ______________(1Week).

If you will include a business card when you return the survey we will be happy to provide you an executive summary of the results in addition to the random drawing for 3 Palm Pilots.

All responses will be held in strict confidence. Neither your name nor your company's name will be recorded with any of the responses.

THANK YOU FOR YOUR TIME

If you have any questions please call:
Zach Zacharia The University of Tennessee,
Department of Marketing, Logistics and Transportation
Suite 309 Conference Center Building, Knoxville, TN 37996-4133
E-mail zacharia@utk.edu, Phone (865) 974-4625 Fax (865) 974-3889

facsimile transmittal

To: **Fax:**

From:	Zach Zacharia	**Date:**	
Re:	New Product Development Survey	**Pages:**	5

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

Dear:

We are inviting you to participate in the University of Tennessee research project regarding logistics involvement in New Product Development for manufacturing companies.

The purpose of this survey will be to obtain your insight and opinions on the impact of logistics in New Product Development. The data we obtain as a result of this survey will help provide business managers and future students valuable information on the degree of logistics impact, or lack of impact, on new product development.

Your firm is one of a small number of firms that have been asked to participate in this research. It does not matter if you have logistics involved in new product development right now, as not having logistics involved is valuable information as well. **In order for the results to truly represent today's management perspective, it is critical to the survey that your insight and opinions be included.**

Your participation in the survey will require only about 12 minutes. To express our appreciation for your assistance, you may enclose a business card and we will send you an Executive Survey of the results. (To preserve your anonymity, the business card will be separated from the survey as soon as it is received.) In addition, everyone who returns a business card will be entered in a random drawing for 3 Palm Pilots.

Please return the survey by February 9th preferably by fax. However, if you prefer to submit electronically, click on http://ctr.utk.edu/zzacharia.htm. All responses will be held in strict confidence. Neither your name nor your company's name will be recorded with any of the responses.

Thank you for your participation.

Cover Letter after contact via phone

Dear

Thank you for agreeing to participate in the University of Tennessee research regarding logistics involvement in New Product Development for manufacturing companies.

The purpose of this survey will be to obtain your insight and opinions on the impact of logistics in New Product Development. The data we obtain as a result of this survey will help provide business managers and future students valuable information on the degree of logistics impact, or lack of impact, on new product development.

Your firm is one of a small number of firms that have been asked to participate in this research. It does not matter if you have logistics involved in new product development right now, as not having logistics involved is valuable information as well. **In order for the results to truly represent today's management perspective, it is critical to the survey that your insight and opinions be included.**

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All responses will be held in strict confidence. Neither your name nor your company's name will be recorded with any of the responses.

Thank you for your participation.

Zach Zacharia
Ph.D. Student

Dr. John T. (Tom) Mentzer, Ph.D.
Bruce Chair of Excellence in Business

The University of Tennessee
Department of Marketing, Logistics and Transportation
Suite 309, Conference Center Building
Knoxville, Tennessee 37996-4133
E-mail zacharia@utk.edu , Phone (865) 974-4625 Fax (865) 974-3889

Initial Personalized E-Mail Letter

Subject: Logistics and New Product Development

Dear Mr. :

Dr. Tom Mentzer and I are conducting a University of Tennessee research project regarding logistics involvement in New Product development.

The purpose of this survey will be to obtain your insight and opinions on the impact of logistics in New Product Development. The data we obtain as a result of this survey will help provide business managers and future students valuable information on the degree of logistics impact, or lack of impact, on new product development.

Your firm is one of a small number of firms that have been asked to participate in this research. It does not matter if you have logistics involved in new product development right now, as not having logistics involved is valuable information as well. In order for the results to truly represent today's management perspective, it is critical to the survey that your insight and opinions be included.

Your participation in the survey will require only about 12 minutes. To express our appreciation for your assistance, you may provide your business card (or contact information via e-mail) and we will send you an Executive Summary of the results. (To preserve your anonymity, the business card/contact information will be separated from the survey as soon as it is received.) In addition, everyone who returns a business card will be entered in a random drawing for 3 Palm Pilots.

Please return the survey attached via fax or fill out the survey directly by following this link to our website:
http://ctr.utk.edu/zzacharia.htm

All responses will be held in strict confidence. Thank you in advance for your participation.

Sincerely,

Zach Zacharia
Ph.D. Student
The University of Tennessee
310 Stokely Management Center
Knoxville, TN, 37996-4133
Ph. (865)974-4625, Fax (865)974-3889

One Week Personalized E-Mail Reminder Letter

Subject: Logistics and New Product Development

Dear Mr. :

Last week, a survey seeking your opinion about logistics and new product development was e-mailed to you. Your name was randomly drawn from a list of manufacturing firms within the U.S.

If you have already completed and returned the survey to us, please accept our sincere thanks. If not, please do so today.

Dr. Tom Mentzer and I are conducting a University of Tennessee research project regarding logistics involvement in New Product development.

The purpose of this survey will be to obtain your insight and opinions on the impact of logistics in New Product Development. The data we obtain as a result of this survey will help provide business managers and future students valuable information on the degree of logistics impact, or lack of impact, on new product development.

Your firm is one of a small number of firms that have been asked to participate in this research. It does not matter if you have logistics involved in new product development right now, as not having logistics involved is valuable information as well. In order for the results to truly represent today's management perspective, it is critical to the survey that your insight and opinions be included.

Your participation in the survey will require only about 12 minutes. To express our appreciation for your assistance, you may provide your business card (or contact information via e-mail) and we will send you an Executive Summary of the results. (To preserve your anonymity, the business card/contact information will be separated from the survey as soon as it is received.) In addition, everyone who returns a business card will be entered in a random drawing for 3 Palm Pilots.

Please return the survey attached via fax or fill out the survey directly by following this link to our website:
http://ctr.utk.edu/zzacharia.htm

All responses will be held in strict confidence. Thank you in advance for your participation.

Sincerely,

Zach Zacharia
Ph.D. Student
The University of Tennessee
310 Stokely Management Center
Knoxville, TN, 37996-4133
Ph. (865)974-4625, Fax (865)974-3889

Three Week Personalized E-Mail Reminder Letter

Subject: Logistics and New Product Development

Dear Mr. :

About 3 weeks ago Dr. Tom Mentzer and I, e-mailed you a survey seeking your opinion about the role of logistics in new product development. Since we have not yet received your completed survey, we urge you to take a few moments to do so now. In case you have misplaced the survey, a copy is attached.

This study is being conducted so that business managers like yourself can help identify the degree of logistics impact or lack of impact in new product development. We are writing to you again because the study's usefulness depends on our receiving a survey from each respondent. Your name was drawn through a random selection process where US manufacturers with logistics departments had an equal chance of being selected. In order for the information from the study to be truly representative, it is essential that each person in the sample return their survey.

Dr. Tom Mentzer and I are conducting a University of Tennessee research project regarding logistics involvement in New Product development.

The purpose of this survey will be to obtain your insight and opinions on the impact of logistics in New Product Development. The data we obtain as a result of this survey will help provide business managers and future students valuable information on the degree of logistics impact, or lack of impact, on new product development.

Your firm is one of a small number of firms that have been asked to participate in this research. It does not matter if you have logistics involved in new product development right now, as not having logistics involved is valuable information as well. In order for the results to truly represent today's management perspective, it is critical to the survey that your insight and opinions be included.

Your participation in the survey will require only about 12 minutes. To express our appreciation for your assistance, you may provide your business card (or contact information via e-mail) and we will send you an Executive Summary of the results. (To preserve your anonymity, the business card/contact information will be separated from the survey as soon as it is received.) In addition, everyone who returns a business card will be entered in a random drawing for 3 Palm Pilots.

Please return the survey attached via fax or fill out the survey directly by following this link to our website:
http://ctr.utk.edu/zzacharia.htm

All responses will be held in strict confidence. Thank you in advance for your participation.

Sincerely,

Demographics Statistics

Summary

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Years	49	15	0	15	2.31	3.01
Annual Sales	47	2	3	5	4.17	.89
Employees	48	6	1	7	5.19	1.38
Company age	48	3	2	5	4.90	.47
Profits from products less than 5 years	45	90	10	100	48.98	32.29
Projects	46	500	0	500	49.65	88.96
Valid N (listwise)	42					

Projects

	Number of Projects	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	2.0	2.2	2.2
	2	5	10.0	10.9	13.0
	3	4	8.0	8.7	21.7
	4	2	4.0	4.3	26.1
	5	4	8.0	8.7	34.8
	9	1	2.0	2.2	37.0
	10	5	10.0	10.9	47.8
	15	2	4.0	4.3	52.2
	20	1	2.0	2.2	54.3
	25	2	4.0	4.3	58.7
	30	3	6.0	6.5	65.2
	35	1	2.0	2.2	67.4
	40	1	2.0	2.2	69.6
	50	3	6.0	6.5	76.1
	60	1	2.0	2.2	78.3
	100	7	14.0	15.2	93.5
	200	1	2.0	2.2	95.7
	300	1	2.0	2.2	97.8
	500	1	2.0	2.2	100.0
	Total	46	92.0	100.0	
Missing	System	4	8.0		
Total		50	100.0		

Profits from products less than 5 years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	7	14.0	15.6	15.6
	15	1	2.0	2.2	17.8
	20	7	14.0	15.6	33.3
	25	2	4.0	4.4	37.8
	30	5	10.0	11.1	48.9
	40	1	2.0	2.2	51.1
	50	3	6.0	6.7	57.8

	60	2	4.0	4.4	62.2
	70	1	2.0	2.2	64.4
	75	1	2.0	2.2	66.7
	80	4	8.0	8.9	75.6
	85	3	6.0	6.7	82.2
	90	4	8.0	8.9	91.1
	95	2	4.0	4.4	95.6
	99	1	2.0	2.2	97.8
	100	1	2.0	2.2	100.0
	Total	45	90.0	100.0	
Missing	System	5	10.0		
Total		50	100.0		

Company age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	2.0	2.1	2.1
	4	2	4.0	4.2	6.3
	5	45	90.0	93.8	100.0
	Total	48	96.0	100.0	
Missing	System	2	4.0		
Total		50	100.0		

Employees

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	2.0	2.1	2.1
	3	4	8.0	8.3	10.4
	4	12	24.0	25.0	35.4
	5	5	10.0	10.4	45.8
	6	19	38.0	39.6	85.4
	7	7	14.0	14.6	100.0
	Total	48	96.0	100.0	
Missing	System	2	4.0		
Total		50	100.0		

Annual Sales

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	15	30.0	31.9	31.9
	4	9	18.0	19.1	51.1
	5	23	46.0	48.9	100.0
	Total	47	94.0	100.0	
Missing	System	3	6.0		
Total		50	100.0		

Descriptive Statistics

Statistics

		N	Mean	Min	Max	Std. Deviation	Skewness	Kurtosis
Y1	Years	50	2.28	0	15	2.98	3.244	11.018
IT1	Minor Improv	50	4.72	1	7	1.40	-.636	.542
IT2	Market Familiar	50	2.72	1	6	1.80	.770	-.803
IT3	Developing Technology	50	3.68	1	7	1.75	.206	-.921
PP1	NP Profit	48	4.25	1	7	1.56	.052	-.513
PP2	NP Budget	47	4.23	1	7	1.49	-.215	.115
PP3	NP Market Share	46	4.37	1	7	1.69	-.211	-.611
PP4	NP Customer satisfaction	48	5.10	1	7	1.36	-.944	.609
PP5	NP Competitive Advantage	47	4.98	1	7	1.45	-.674	-.169
PP6	NP Speed to Mkt	49	4.53	2	7	1.34	-.203	-1.101
PP7	NP Quality/Performance	49	5.16	1	7	1.33	-.979	1.151
CFI1	Work Togeth	50	5.22	2	7	1.43	-.664	-.376
CFI2	Share Info	49	4.84	2	7	1.46	-.288	-.905
CFI3	Share resources	50	4.28	1	7	1.59	-.007	-.736
CFI4	Collective Goals	50	4.64	1	7	1.60	-.094	-.846
CFI5	Teamwork	50	4.70	2	7	1.52	-.051	-.997
LIT1	First Involvement	50	4.58	1	7	1.93	-.296	-1.115
LIM1	Idea Generation	50	1.66	1	7	1.52	2.823	7.549
LIM2	Idea Screening	50	1.92	1	7	1.79	2.047	3.129
LIM3	Market Analysis	50	1.86	1	7	1.58	2.090	3.775
LIM4	Development	50	2.56	1	7	1.99	1.030	-.268
LIM5	Testing	50	3.16	1	7	2.15	.387	-1.338
LIM6	Launch	50	4.86	1	7	2.35	-.771	-.987
LIQ1	Creativity	49	3.33	1	7	2.05	.451	-.945
LIQ2	Indep contribution	49	3.63	1	7	2.08	.123	-1.209
LIQ3	Ideas generated	49	3.22	1	7	1.94	.455	-.769
LIQ4	ideas implemented	49	3.20	1	7	1.90	.394	-1.007
LIQ5	Influential	50	3.00	1	7	1.76	.700	-.239
LIQ6	directly impacted	50	3.40	1	7	2.12	.265	-1.292
LIR1	Committed	50	4.42	1	7	2.28	-.610	-1.250
LIR2	cooperative	50	4.44	1	7	2.30	-.566	-1.261
LIR3	highly valued	50	3.76	1	7	2.00	-.152	-1.284
LP1	Logistics costs	50	3.54	1	7	1.66	-.256	-.754
LP2	order fill rate	48	4.46	2	7	1.32	.412	-.398
LP3	on_time delivery	47	4.64	2	7	1.39	-.172	-.610
LP4	Damage free	48	4.85	1	7	1.62	-.687	.078
LP5	equipment utilization	47	4.81	1	7	1.33	-.212	.414
LP6	transit time	47	4.68	1	7	1.30	.014	.191
DI1	Important	48	5.06	0	7	1.74	-.930	.420
DI2	Visibility	49	4.92	0	7	1.68	-.854	.413
DI3	Access	49	5.00	0	7	1.72	-.845	.326

DI4	decision making	49	4.59	0	7	1.67	-.573	.041
AP1	Cost advantage	48	4.79	0	7	1.77	-.792	.151
AP2	service quality advantage	49	5.61	0	7	1.71	-1.671	2.639
AP3	Log competitive advantage	49	5.06	0	7	1.74	-1.068	.789
AP4	Log profitability	49	4.63	0	7	1.78	-.716	.057
EU1	env rarely change mktg	49	4.10	1	7	1.87	-.055	-1.156
EU2	env product obsolescence	49	3.94	1	7	2.00	.007	-1.393
EU3	env technology obsolescence	49	3.94	1	7	2.07	-.048	-1.434
EU4	env competitors actions	49	3.78	1	7	1.48	.162	-.445
EU5	env easy to forecast demand	48	2.77	1	7	1.45	.946	.743
TQBC1	JIT	49	4.31	1	7	1.88	-.113	-1.216
TQBC2	VMI	49	4.51	1	7	1.83	-.316	-1.128
TQBC3	AR_CR	49	4.24	1	7	1.70	-.110	-.946
TQBC4	QR	49	4.35	1	7	1.88	-.155	-1.125
TQBC5	ECR	49	3.86	1	7	1.87	.077	-.966
TQBC6	CFP	45	3.76	1	7	1.91	.038	-1.104
GF1	Global sourcing	49	4.41	1	7	1.96	-.187	-1.356
GF2	Global competition	49	4.84	1	7	1.70	-.477	-.756
GF3	Global Manufacturing	49	4.45	1	7	1.73	-.236	-.727
IIT1	EDI	49	5.65	2	7	1.38	-.882	-.109
IIT2	Internet	49	5.29	2	7	1.59	-.620	-.631
IIT3	E_commerce	49	4.53	1	7	1.85	-.092	-1.112
IIT4	Real Time Product Tracking	49	4.06	1	7	1.89	-.072	-.974
IIT5	Supply Chain Information System	49	4.80	2	7	1.71	-.322	-1.302
IIT6	ERP	48	4.98	1	7	1.68	-.582	-.585
IIT7	APS	47	4.91	1	7	1.52	-.398	-.574
	Title	50						
	Department	50						
	Projects	47	48.72	0	500	88.21	3.641	15.661
	Industry	50						
	Profits from products less than 5 years	46	48.02	5	100	32.58	.258	-1.601
	Company age	49	4.90	2	5	.47	-5.472	32.313
	Employees	49	5.16	1	7	1.37	-.658	.115
	Annual Sales	48	4.15	3	5	.90	-.298	-1.727

Factor Analysis and Reliability

Innovation Level

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.612	53.740	53.740	1.612	53.740	53.740
2	.787	26.241	79.981			
3	.601	20.019	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
Minor Improv	.781
Market Familiar	.647
Developing Technology	.764

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

                  Correlation Matrix

              MINOR_IM     MARKET_F     DEVELOPI

MINOR_IM       1.0000
MARKET_F        .2765       1.0000
DEVELOPI        .3947        .2365       1.0000

      N of Cases =        50.0

Item-total Statistics

              Scale          Scale       Corrected
              Mean         Variance        Item-          Squared          Alpha
             if Item        if Item        Total          Multiple        if Item
             Deleted        Deleted      Correlation     Correlation      Deleted

MINOR_IM      6.4000         7.7959         .4259           .1913          .3824
MARKET_F      8.4000         6.9796         .3036           .0957          .5558
DEVELOPI      7.4400         6.5780         .3811           .1733          .4229

Reliability Coefficients      3 items

Alpha =    .5526          Standardized item alpha =    .5655
```

Project Performance

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.881	72.037	72.037	2.881	72.037	72.037
2	.775	19.377	91.414			
3	.187	4.665	96.079			
4	.157	3.921	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
NP Profit	.925
NP Budget	.938
NP Market Share	.913
NP Speed to Mkt	.560

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)

                                Mean          Std Dev         Cases

  1.     NP_PROFI             4.3333          1.5811          45.0
  2.     NP_BUDGE             4.2222          1.5209          45.0
  3.     NP_MARKE             4.4000          1.6976          45.0
  4.     NP_SPEED             4.4444          1.3409          45.0

                    Covariance Matrix

                NP_PROFI     NP_BUDGE     NP_MARKE     NP_SPEED

NP_PROFI         2.5000
NP_BUDGE         2.0152       2.3131
NP_MARKE         2.1818       2.1364       2.8818
NP_SPEED          .8030        .8535        .7727       1.7980


                    Correlation Matrix

                NP_PROFI     NP_BUDGE     NP_MARKE     NP_SPEED
```

NP_PROFI	1.0000			
NP_BUDGE	.8380	1.0000		
NP_MARKE	.8129	.8274	1.0000	
NP_SPEED	.3788	.4185	.3395	1.0000

N of Cases = 45.0

Statistics for	Mean	Variance	Std Dev	N of Variables
Scale	17.4000	27.0182	5.1979	4

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	4.3500	4.2222	4.4444	.2222	1.0526	.0093

Reliability Coefficients 4 items

Alpha = .8649 Standardized item alpha = .8584

Cross-Functional Integration

Communalities
Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.867	77.338	77.338	3.867	77.338	77.338
2	.428	8.558	85.895			
3	.279	5.572	91.467			
4	.247	4.946	96.413			
5	.179	3.587	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
Work Togeth	.840
Share Info	.894
Share resources	.853
Collective Goals	.906
Teamwork	.902

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)


                              Mean        Std Dev       Cases

  1.     WORK_TOG           5.2292        1.4475        48.0
  2.     SHARE_IN           4.8125        1.4682        48.0
  3.     SHARE_RE           4.2500        1.6045        48.0
  4.     COLLECTI           4.6875        1.6132        48.0
  5.     TEAMWORK           4.7083        1.5153        48.0

        N of Cases =        48.0

                                                        N of
Statistics for        Mean    Variance    Std Dev   Variables
      Scale        23.6875     45.2407     6.7261           5
```

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	4.7375	4.2500	5.2292	.9792	1.2304	.1221

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
WORK_TOG	18.4583	31.0195	.7520	.5960	.9195
SHARE_IN	18.8750	29.8138	.8277	.6981	.9054
SHARE_RE	19.4375	29.2726	.7714	.6378	.9166
COLLECTI	19.0000	28.1277	.8480	.7334	.9009
TEAMWORK	18.9792	29.2123	.8384	.7147	.9030

Reliability Coefficients 5 items

Alpha = .9261 Standardized item alpha = .9265

Logistics Involvement Magnitude

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.215	64.294	64.294	3.215	64.294	64.294
2	.975	19.508	83.802			
3	.428	8.566	92.368			
4	.234	4.676	97.044			
5	.148	2.956	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
Idea Generation	.812
Idea Screening	.878
Market Analysis	.808
Development	.829
Testing	.668

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)

                             Mean        Std Dev       Cases

  1.     IDEA_GEN           1.8462       1.6786        39.0
  2.     IDEA_SCR           2.1795       1.9584        39.0
  3.     MARKET_A           2.1026       1.7136        39.0
  4.     DEVELOPM           3.1026       2.0493        39.0
  5.     TESTING            3.8718       2.0155        39.0

                                                     N of
Statistics for        Mean    Variance    Std Dev  Variables
      SCALE        13.1026     56.6734     7.5282          5


Reliability Coefficients

N of Cases =     39.0                     N of Items =  5

Alpha =    .8563
```

Logistics Involvement Quality

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.924	65.393	65.393	3.924	65.393	65.393
2	.787	13.123	78.516			
3	.489	8.151	86.666			
4	.391	6.513	93.180			
5	.235	3.924	97.104			
6	.174	2.896	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
creativity	.854
Indep contribution	.853
ideas generated	.878
ideas implemented	.773
influential	.796
directly impacted	.681

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)

                                Mean          Std Dev        Cases

  1.     CREATIVI             4.0000          1.7638          37.0
  2.     INDEP_CO             4.5676          1.6422          37.0
  3.     IDEAS_GE             3.9459          1.6824          37.0
  4.     IDEAS_IM             3.9189          1.6730          37.0
  5.     INFLUENT             3.5405          1.5916          37.0
  6.     DIRECTLY             4.1622          1.8784          37.0

                                                         N of
Statistics for        Mean    Variance     Std Dev  Variables
      SCALE        24.1351     67.7868      8.2333          6


Reliability Coefficients

N of Cases =     37.0                     N of Items =  6

Alpha =    .8902
```

Logistics Involvement Relationship

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.692	89.740	89.740	2.692	89.740	89.740
2	.268	8.939	98.680			
3	3.961E-02	1.320	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
committed	.971
cooperative	.968
highly valued	.902

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)

                                Mean        Std Dev       Cases

  1.     COMMITTE              5.5250        1.3395        40.0
  2.     COOPERAT              5.5750        1.3939        40.0
  3.     HIGHLY_V              4.6500        1.3877        40.0


Reliability Coefficients

N of Cases =      40.0                    N of Items =  3

Alpha =    .9418
```

Logistics Performance

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.895	57.894	57.894	2.895	57.894	57.894
2	.994	19.874	77.768			
3	.708	14.164	91.933			
4	.219	4.382	96.315			
5	.184	3.685	100.000			

Extraction Method: Principal Component Analysis.

Total Variance Explained
Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
order fill rate	.749
on_time delivery	.834
equipment utilization	.850
transit time	.785
damage free	.548

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)
                                   Mean         Std Dev        Cases

  1.      ORDER_FI             4.4222          1.3054          45.0
  2.      ON_TIME              4.7111          1.4242          45.0
  3.      EQUIPMEN             4.8222          1.3533          45.0
  4.      TRANSIT              4.6667          1.3143          45.0
  5.      DAMAGE_F             4.8444          1.6370          45.0

        N of Cases =          45.0

                                                          N of
Statistics for         Mean    Variance     Std Dev   Variables
      Scale         23.4667     27.8455      5.2769           5

Inter-item
Correlations           Mean     Minimum     Maximum       Range     Max/Min
Variance
                      .4624       .2229       .8006       .5777      3.5922
.0355

Reliability Coefficients      5 items

Alpha =   .8024          Standardized item alpha =   .8113
```

Degree of Importance

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.457	86.430	86.430	3.457	86.430	86.430
2	.271	6.782	93.212			
3	.166	4.142	97.354			
4	.106	2.646	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
important	.896
visibility	.942
Access	.953
decision making	.927

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)

        N of Cases =        48.0

                                                       N of
Statistics for        Mean    Variance     Std Dev  Variables
      Scale        19.7292     40.4570      6.3606          4

Item Means            Mean     Minimum     Maximum       Range     Max/Min
Variance
                    4.9323      4.6458      5.0625       .4167      1.0897
.0389

Item-total Statistics

               Scale          Scale       Corrected
               Mean          Variance       Item-          Squared
Alpha
              if Item        if Item        Total          Multiple
if Item
              Deleted        Deleted     Correlation     Correlation
Deleted

IMPORTAN      14.6667        23.5461        .8200           .6816
.9474
VISIBILI      14.7708        22.9889        .8939           .8064
.9244
```

ACCESS	14.6667	22.6099	.9113	.8470
.9189				
DECISION	15.0833	23.4823	.8677	.7834
.9325				

Reliability Coefficients   4 items

Alpha =   .9473   Standardized item alpha =   .9475

Advantage Provided

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.231	80.775	80.775	3.231	80.775	80.775
2	.340	8.501	89.276			
3	.274	6.856	96.132			
4	.155	3.868	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
cost advantage	.863
service quality advantage	.926
Log competitive advantage	.920
Log profitability	.885

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)


                                    Mean          Std Dev        Cases

  1.      COST_ADV                 4.8750          1.7336         48.0
  2.      SERVICE                  5.6250          1.7213         48.0
  3.      LOG_COMP                 5.0417          1.7499         48.0
  4.      LOG_PROF                 4.7083          1.7620         48.0


                        Correlation Matrix

                 COST_ADV     SERVICE      LOG_COMP     LOG_PROF

COST_ADV         1.0000
SERVICE           .7398       1.0000
LOG_COMP          .6961        .8388       1.0000
LOG_PROF          .6774        .7419        .7631       1.0000



        N of Cases =        48.0

                                                          N of
```

Statistics for	Mean	Variance	Std Dev	Variables		
Scale	20.2500	39.1702	6.2586	4		

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	5.0625	4.7083	5.6250	.9167	1.1947	.1591

Item Variances	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.0337	2.9628	3.1046	.1418	1.0479	.0039

Inter-item Correlations	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.7428	.6774	.8388	.1614	1.2383	.0029

Reliability Coefficients   4 items

Alpha =   .9203   Standardized item alpha =   .9204

Environmental Uncertainty

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.691	53.816	53.816	2.691	53.816	53.816
2	.885	17.700	71.516			
3	.653	13.069	84.585			
4	.516	10.314	94.900			
5	.255	5.100	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
env rarely change mktg	.710
env product obsolescence	.865
env technology obsolescence	.828
env competitors actions	.756
env easy to forecast demand	.426

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)

                              Mean        Std Dev       Cases

  1.     ENV_RARE           3.9167         1.8431        48.0
  2.     ENV_PROD           3.8958         1.9919        48.0
  3.     ENV_TECH           3.8750         2.0382        48.0
  4.     ENV_COMP           3.7083         1.4136        48.0
  5.     ENV_EASY           2.7917         1.4286        48.0


                    Correlation Matrix

                ENV_RARE     ENV_PROD     ENV_TECH     ENV_COMP
ENV_EASY

ENV_RARE         1.0000
ENV_PROD          .5018       1.0000
ENV_TECH          .3880        .7304       1.0000
ENV_COMP          .4559        .5255        .5114       1.0000
ENV_EASY          .2357        .2464        .2466        .1800
1.0000
```

N of Cases = 48.0

Statistics for	Mean	Variance	Std Dev	N of Variables
Scale	18.1875	41.1769	6.4169	5

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.6375	2.7917	3.9167	1.1250	1.4030	.2304

Item Variances	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.1116	1.9982	4.1543	2.1560	2.0790	1.0719

Inter-item Correlations	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.4022	.1800	.7304	.5504	4.0581	.0288

Reliability Coefficients 5 items

Alpha = .7777 Standardized item alpha = .7708

Time and Quality Based Competition

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.941	65.691	65.691	3.941	65.691	65.691
2	.776	12.931	78.622			
3	.503	8.384	87.006			
4	.358	5.960	92.967			
5	.289	4.815	97.782			
6	.133	2.218	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
JIT	.598
VMI	.817
AR_CR	.823
QR	.850
ECR	.880
CFP	.861

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)


        N of Cases =        45.0

                                                        N of
Statistics for        Mean    Variance     Std Dev   Variables
      Scale        24.6444     82.6889      9.0933           6

Item Means            Mean     Minimum     Maximum       Range     Max/Min
Variance
                    4.1074      3.6667      4.4222       .7556      1.2061
.0878


Item-total Statistics

               Scale          Scale        Corrected
               Mean         Variance         Item-          Squared
Alpha
             if Item         if Item         Total          Multiple
if Item
```

	Deleted	Deleted	Correlation	Correlation
Deleted				
JIT	20.3111	63.4465	.4868	.3930
.9070				
VMI	20.2222	58.4495	.7158	.5622
.8703				
AR_CR	20.5333	60.5273	.7238	.5958
.8700				
QR	20.3778	57.0131	.7692	.6020
.8617				
ECR	20.8000	55.5273	.8148	.7684
.8539				
CFP	20.9778	57.1131	.7676	.7540
.8619				

Reliability Coefficients   6 items

Alpha =   .8906   Standardized item alpha =   .8920

Global Factors

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.278	75.941	75.941	2.278	75.941	75.941
2	.405	13.487	89.428			
3	.317	10.572	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
Global sourcing	.877
Global competition	.885
Global Manufacturing	.852

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)


                                  Mean        Std Dev       Cases

  1.     GLOBAL_S               4.3469        1.9208        49.0
  2.     GLOBAL_C               4.8367        1.6998        49.0
  3.     GLOBAL_M               4.4286        1.7078        49.0


                         Correlation Matrix

                  GLOBAL_S     GLOBAL_C     GLOBAL_M

GLOBAL_S           1.0000
GLOBAL_C            .6813       1.0000
GLOBAL_M            .6079        .6274       1.0000


        N of Cases =          49.0

                                                          N of
Statistics for        Mean     Variance     Std Dev   Variables
      Scale        13.6122      21.5757      4.6450           3

Item Means            Mean      Minimum     Maximum       Range     Max/Min
Variance
```

	Mean	Minimum	Maximum	Range	Max/Min	Variance
	4.5374	4.3469	4.8367	.4898	1.1127	.0689
Item Variances	3.1652	2.8895	3.6896	.8002	1.2769	.2064
Inter-item Correlations	.6389	.6079	.6813	.0734	1.1208	.0012

Reliability Coefficients 3 items

Alpha = .8398 Standardized item alpha = .8414

E-Commerce Factors

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.181	72.693	72.693	2.181	72.693	72.693
2	.500	16.653	89.345			
3	.320	10.655	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
EDI	.806
Internet	.877
E_commerce	.873

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)


                                Mean        Std Dev       Cases

  1.      EDI                 5.6122         1.3665        49.0
  2.      INTERNET            5.2857         1.5943        49.0
  3.      E_COMMER            4.5102         1.8610        49.0


                        Correlation Matrix

                EDI          INTERNET     E_COMMER

EDI             1.0000
INTERNET         .5492        1.0000
E_COMMER         .5382         .6801       1.0000



        N of Cases =        49.0

                                                    N of
Statistics for        Mean    Variance     Std Dev  Variables
      Scale         15.4082    17.0383     4.1277          3

Item Means            Mean     Minimum     Maximum       Range      Max/Min
Variance
                    5.1361      4.5102      5.6122      1.1020       1.2443
.3204
```

Item Variances	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.6241	1.8673	3.4634	1.5961	1.8547	.6420

Inter-item Correlations	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.5892	.5382	.6801	.1419	1.2637	.0050

Reliability Coefficients   3 items

Alpha =   .8069   Standardized item alpha =   .8114

Improving Information Technology

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.847	71.172	71.172	2.847	71.172	71.172
2	.487	12.170	83.342			
3	.426	10.638	93.980			
4	.241	6.020	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
Real Time Product Tracking	.818
Supply Chain Information System	.903
ERP	.792
APS	.858

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H
A)

                                 Mean        Std Dev       Cases

  1.     REAL_TIM              3.9787         1.9392        47.0
  2.     SUPPLY_C              4.8298         1.6981        47.0
  3.     ERP                   4.9787         1.7002        47.0
  4.     APS                   4.8936         1.5070        47.0


                         Correlation Matrix

                REAL_TIM     SUPPLY_C     ERP          APS

REAL_TIM        1.0000
SUPPLY_C         .6657       1.0000
ERP              .5207        .6161       1.0000
APS              .5794        .7403        .5591       1.0000


        N of Cases =        47.0
```

Statistics for Scale	Mean	Variance	Std Dev	N of Variables
Scale	18.6809	33.2220	5.7639	4

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	4.6702	3.9787	4.9787	1.0000	1.2513	.2162

Item Variances	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.9514	2.2710	3.7604	1.4894	1.6558	.3752

Inter-item Correlations	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.6136	.5207	.7403	.2196	1.4217	.0057

Reliability Coefficients 4 items

Alpha = .8595 Standardized item alpha = .8640

APPENDIX III

FINAL SAMPLE

FINAL SURVEY

GENERAL INSTRUCTIONS

I am interested in your general perception of the new product development process in your firm for a specific project. Therefore as you are filling out this survey, please think of the most **recent**, new product project that you have been involved in, that has been in the market for at least a year.

Section 1 - New Product Project Description

1. Approximately how many years has this product been in the marketplace? ___________years

2. In comparison to existing products in the firm this product's degree of improvement is...	Minor Improvement						Radical Break-through
	1	2	3	4	5	6	7
3. To what extent was the company familiar with the market for this product class?	Highly Familiar						Not Familiar
	1	2	3	4	5	6	7
4. To what extent was the new product based new on existing technology?	Known Technology						Developing, Technology
	1	2	3	4	5	6	7
5. To what extent did this new product meet its....	Fell Far Short						Far Exceeded
a) profit objectives	1	2	3	4	5	6	7
b) budget objectives	1	2	3	4	5	6	7
c) market share objectives	1	2	3	4	5	6	7
d) customer satisfaction objectives	1	2	3	4	5	6	7
e) competitive advantage objectives	1	2	3	4	5	6	7
f) speed to market objectives	1	2	3	4	5	6	7
g) quality or performance objectives	1	2	3	4	5	6	7
6. During new product development departments within the firm...	Strongly Disagree						Strongly Agree
a) are encouraged to work together	1	2	3	4	5	6	7
b) share information and provide input	1	2	3	4	5	6	7
c) share resources	1	2	3	4	5	6	7
d) achieve goals collectively	1	2	3	4	5	6	7
e) informally work together as a team	1	2	3	4	5	6	7

Section 2 - Logistics Involvement

7. When did Logistics/Distribution first become involved in the new product development project (from just started to 100% completed)?

0% Complete			50% Complete			100% Complete
1	2	3	4	5	6	7

If logistics was not directly involved in the new product development project until 100% complete, please skip question 8 - 10 and go to question 11; otherwise please continue:

8. In this project team, logistics during...	Not Involved						Highly Involved
a) Idea Generation was...	1	2	3	4	5	6	7
b) Idea Screening was...	1	2	3	4	5	6	7
c) Market Analysis was...	1	2	3	4	5	6	7
d) Product Development was...	1	2	3	4	5	6	7
e) Product Testing was...	1	2	3	4	5	6	7
f) Product Launch was...	1	2	3	4	5	6	7

9. Once logistics became involved, the level of logistics

	Low						High
a) creativity was...	1	2	3	4	5	6	7
b) independent contribution was...	1	2	3	4	5	6	7
c) ideas generated (number of ideas) were...	1	2	3	4	5	6	7
d) ideas that were implemented were...	1	2	3	4	5	6	7

10. In this project team, logistics...	Strongly Disagree						Strongly Agree
a)...was influential	1	2	3	4	5	6	7
b)...directly impacted the outcome	1	2	3	4	5	6	7
c)...was highly committed	1	2	3	4	5	6	7
d)...was highly cooperative	1	2	3	4	5	6	7
e)...was highly valued by other team members	1	2	3	4	5	6	7

11. In your opinion, compared to other new products developed within your firm, this product's..	Far Below Average						Far Above Average
a) logistics/distribution costs were...	1	2	3	4	5	6	7
b) orders that were filled as requested were...	1	2	3	4	5	6	7
c) on time delivery was...	1	2	3	4	5	6	7
d) number of damage free deliveries was...	1	2	3	4	5	6	7
e) utilization of transportation equipment was...	1	2	3	4	5	6	7
f) transit time to customer was...	1	2	3	4	5	6	7

Section 3 – Logistics/Distribution Description

12. The logistics/distribution department is an important department in your firm	Strongly Disagree 1	2	3	4	5	6	Strongly Agree 7

13. The logistics department has become important in the firm in terms of…	Strongly Disagree						Strongly Agree
a) visibility within the firm	1	2	3	4	5	6	7
b) degree of access to top management	1	2	3	4	5	6	7
c) degree of decision-making influence	1	2	3	4	5	6	7
d) a cost advantage	1	2	3	4	5	6	7
e) a service quality advantage	1	2	3	4	5	6	7
f) a competitive advantage	1	2	3	4	5	6	7
g) a profitability advantage	1	2	3	4	5	6	7

Section 4 – Industry Description

14. In your industry…	Strongly Disagree						Strongly Agree
a) firms rarely change their marketing practices	1	2	3	4	5	6	7
b) the rate of product obsolescence is slow	1	2	3	4	5	6	7
c) the rate of technology obsolescence is slow	1	2	3	4	5	6	7
d) actions of competitors are easy to predict	1	2	3	4	5	6	7
e) demand is easy to forecast	1	2	3	4	5	6	7

15. How extensively are the following used in your industry:	Not Used						Greatly Used
a) Just-In-Time	1	2	3	4	5	6	7
b) Vendor Managed Inventory	1	2	3	4	5	6	7
c) Automatic/Continuous Replenishment	1	2	3	4	5	6	7
d) Quick Response	1	2	3	4	5	6	7
e) Efficient Consumer Response	1	2	3	4	5	6	7
f) CPFR	1	2	3	4	5	6	7

16. In your industry…	Strongly Disagree						Strongly Agree
a) global sourcing is the norm	1	2	3	4	5	6	7
b) global competition is the norm	1	2	3	4	5	6	7
c) global manufacturing is the norm	1	2	3	4	5	6	7

17. How extensively are the following technologies used in your industry for business:

	Not Used						Greatly Used
a) Electronic Data Interchange	1	2	3	4	5	6	7
b) Internet	1	2	3	4	5	6	7
c) E-Commerce	1	2	3	4	5	6	7
d) Real Time Product Tracking	1	2	3	4	5	6	7
e) Supply Chain Information systems	1	2	3	4	5	6	7
f) Enterprise Resource Planning (ERP)	1	2	3	4	5	6	7
g) Advance Planning and Scheduling Systems	1	2	3	4	5	6	7

<u>Section 5 - Respondent/Firm Description</u>

18. What is your title? ____

19. What is your department? ___Marketing ___R&D ___Manufacturing ___Logistics ___New Products

___Sales ___Finance ___Other (Describe)____

20. Approximately how many new product projects have you been involved in your career? ____________

21. The primary industry in which your firm competes:

____Food/Beverages/Tobacco ____Chemicals ___Pharmaceuticals/health and beauty aids

___Electronics/computers ___Transportation/motor equipment ___Metals/minerals/petroleum/rubber

____Building materials ___Other (Please describe) ______________________________________

22.In your opinion, what percent of your company's profits come from products less than 5 years old? _____%

23. The approximate age of the company __<2years __2-5years __6-10years __11-15years __>16years

24. Indicate the size of your company worldwide by the approximate number of employees.

a)__<100 b)__101-500 c)__501-1000 d)__1001-5000 e)__5001-10,000 f)__10,001-50,000 g)__>50,000

25. Approximately, what is your company's worldwide annual sales?

a)___<$10 Million b)____$11-$99 Million c)____$100-$999 Million d)____$1-5 Billion e)___>$6 Billion

Thank you again for your time and assistance.
(Don't forget to include your business card if you would like
to receive a copy of the executive summary and enter the drawing for 3 palm pilots.)

Upon completion, please fax to (865) 974-3889 or mail to

Zach Zacharia, The University of Tennessee,

Department of Marketing, Logistics and Transportation, Suite 309 Conference Center Building,

Knoxville, TN 37996-4133, E-mail zacharia@utk.edu, Phone (865) 974-4625, Fax (865) 974-3889

INITIAL PERSONALIZED E-MAIL LETTER

Subject: Logistics and New Product Development

Dear Mr. :

Dr. Tom Mentzer and I are conducting a University of Tennessee research project regarding logistics involvement in New Product development.

The purpose of this survey will be to obtain your insight and opinions on the impact of logistics in New Product Development. The data we obtain as a result of this survey will help provide business managers and future students valuable information on the degree of logistics impact, or lack of impact, on new product development.

Your firm is one of a small number of firms that have been asked to participate in this research. It does not matter if you have logistics involved in new product development right now, as not having logistics involved is valuable information as well. In order for the results to truly represent today's management perspective, it is critical to the survey that your insight and opinions be included.

Your participation in the survey will require only about 12 minutes. To express our appreciation for your assistance, you may provide your business card (or contact information via e-mail) and we will send you an Executive Summary of the results. (To preserve your anonymity, the business card/contact information will be separated from the survey as soon as it is received.) In addition, everyone who returns a business card will be entered in a random drawing for 3 Palm Pilots.

Please return the survey attached via fax or fill out the survey directly by following this link to our website:
http://ctr.utk.edu/zzacharia.htm

All responses will be held in strict confidence. Thank you in advance for your participation.

Sincerely,

Zach Zacharia
Ph.D. Student
The University of Tennessee
310 Stokely Management Center
Knoxville, TN, 37996-4133
Ph. (865)974-4625, Fax (865)974-3889

ONE WEEK PERSONALIZED E-MAIL REMINDER LETTER

Subject: Logistics and New Product Development

Dear Mr. :

Last week, a survey seeking your opinion about logistics and new product development was e-mailed to you. Your name was randomly drawn from a list of manufacturing firms within the U.S.

If you have already completed and returned the survey to us, please accept our sincere thanks. If not, please do so today.

Dr. Tom Mentzer and I are conducting a University of Tennessee research project regarding logistics involvement in New Product development.

The purpose of this survey will be to obtain your insight and opinions on the impact of logistics in New Product Development. The data we obtain as a result of this survey will help provide business managers and future students valuable information on the degree of logistics impact, or lack of impact, on new product development.

Your firm is one of a small number of firms that have been asked to participate in this research. It does not matter if you have logistics involved in new product development right now, as not having logistics involved is valuable information as well. In order for the results to truly represent today's management perspective, it is critical to the survey that your insight and opinions be included.

Your participation in the survey will require only about 12 minutes. To express our appreciation for your assistance, you may provide your business card (or contact information via e-mail) and we will send you an Executive Summary of the results. (To preserve your anonymity, the business card/contact information will be separated from the survey as soon as it is received.) In addition, everyone who returns a business card will be entered in a random drawing for 3 Palm Pilots.

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All responses will be held in strict confidence. Thank you in advance for your participation.

Sincerely,

Zach Zacharia
Ph.D. Student
The University of Tennessee
310 Stokely Management Center
Knoxville, TN, 37996-4133
Ph. (865)974-4625, Fax (865)974-3889

THREE WEEK PERSONALIZED E-MAIL REMINDER LETTER

Subject: Logistics and New Product Development

Dear Mr. :

About 3 weeks ago Dr. Tom Mentzer and I, e-mailed you a survey seeking your opinion about the role of logistics in new product development. Since we have not yet received your completed survey, we urge you to take a few moments to do so now. In case you have misplaced the survey, a copy is attached.

This study is being conducted so that business managers like yourself can help identify the degree of logistics impact or lack of impact in new product development. We are writing to you again because the study's usefulness depends on our receiving a survey from each respondent. Your name was drawn through a random selection process where US manufacturers with logistics departments had an equal chance of being selected. In order for the information from the study to be truly representative, it is essential that each person in the sample return their survey.

Dr. Tom Mentzer and I are conducting a University of Tennessee research project regarding logistics involvement in New Product development.

The purpose of this survey will be to obtain your insight and opinions on the impact of logistics in New Product Development. The data we obtain as a result of this survey will help provide business managers and future students valuable information on the degree of logistics impact, or lack of impact, on new product development.

Your firm is one of a small number of firms that have been asked to participate in this research. It does not matter if you have logistics involved in new product development right now, as not having logistics involved is valuable information as well. In order for the results to truly represent today's management perspective, it is critical to the survey that your insight and opinions be included.

Your participation in the survey will require only about 12 minutes. To express our appreciation for your assistance, you may provide your business card (or contact information via e-mail) and we will send you an Executive Summary of the results. (To preserve your anonymity, the business card/contact information will be separated from the survey as soon as it is received.) In addition, everyone who returns a business card will be entered in a random drawing for 3 Palm Pilots.

Please return the survey attached via fax or fill out the survey directly by following this link to our website:
http://ctr.utk.edu/zzacharia.htm

All responses will be held in strict confidence. Thank you in advance for your participation.

Sincerely,

NOT APPLICABLE PERSONALIZED E-MAIL REMINDER LETTER

Subject: Not Applicable?

Dear Mr. :

If this Logistics and New Product Development survey is not applicable or if you are unwilling/unable to respond could you please reply and indicate that? This will also help me drop you off the e-mail list.

Dr. Tom Mentzer and I are conducting a University of Tennessee research project regarding logistics involvement in New Product development.

The purpose of this survey will be to obtain your insight and opinions on the impact of logistics in New Product Development. The data we obtain as a result of this survey will help provide business managers and future students valuable information on the degree of logistics impact, or lack of impact, on new product development.

Your firm is one of a small number of firms that have been asked to participate in this research. It does not matter if you have logistics involved in new product development right now, as not having logistics involved is valuable information as well. In order for the results to truly represent today's management perspective, it is critical to the survey that your insight and opinions be included.

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All responses will be held in strict confidence. Thank you in advance for your participation.

Sincerely,

Zach Zacharia
Ph.D. Student
The University of Tennessee
310 Stokely Management Center
Knoxville, TN, 37996-4133
Ph. (865)974-4625, Fax (865)974-3889

RESPONDENT TITLES

Americas Logistics Manager
Americas Logistics Manager
Analyst
Assistant Manager
Associate Director Supply Chain Management
Associate Director Supply Chain Management
Business Process Owner
Chief Engineer, Product Support
corp.logistics manager
Corporate Logistics Manager
Corporate Warehousing Manager
Corporate Warehousing Manager
DC
Demand/Supply Leader - Americas
Diector, Product Supply
Dir Logistics
Dir Logistics & Sup Chain Dev
Dir Supply Chain
Dir. Of Procurement
Dir.Logistics Business Development
Director-Supply Chain Planning
Director - Logistics
Director - New Product Development
Director
Director
Director
Director
Director
Director
Director foreign Trade
Director Logistics
Director of Bus Excellence
Director of Customer Service
Director of Distribution
Director of Distribution
Director of Distribution
Director of Distribution
Director of Distribution
Director of Distribution
Director of Engineering
Director of Engineering
Director of Fulfillment Americas
Director of Global Logistics
Director of Global Logistics Systems & Compliance
Director of Global Logistics Systems & Compliance
Director of IS
Director of Logistics
Director of Logistics
Director of Logistics
Director of Logistics
Director of Logistics
Director of Logistics
Director of Logistics
Director of Logistics
DIRECTOR OF LOGISTICS
Director of Materials
Director of Materials
Director of Materials & Logistics
Director of Operations
Director of Operations
Director of Supply Chain
Director of Supply Chain, Consumer Packaging
Director of Transportation
Director of Warehousing Operations
Director Supply Chain
Director Supply Chain Integration
Director Supply Chain Operations
Director Transportation Logistics
Director, Corporate Transportation
Director, Demand Management, North America
Director, Distribution
Director, Global Logisticsq
Director, Global Transportation & Logistics
Director, Logistics & Planning
Director, Logistics Asia-Pacific
Director, New Product Logistics
Director, North American Customer Logistics/Financial Services
Director, ReplacementProducts
Director, ReplacementProducts
Director, Strategic Initiatives
Director, Strategic Initiatives
Director, Supply Chain
Director, Supply Chain Management
Director, Supply Chain Management
Distribution
Distribution and Storage Manager
Distribution Center Senior Coordinator
Distribution Director
Distribution Manager
Distribution Manager
Distribution Manager
Distribution Manger
distribution mgr
DistributionStategy Mgr
Division Operations Manager
Domestic Transportation Manager

e-Business Process &
Technology Leader
Executive Vice President
Executive Vice President
Freight Services
Administrator
Freight Services
Administrator
Global Business Planning
Global Logistics Director
Global Logistics Manager
Global Logistics Team
Lead
Global Logistics
Technology and
Optimization Manager
Global
Logistics/Replenishment
Global Manager Logistics
Global Sourcing Business
Analyst
Global Supply Chain
Leader
Global Trade & Logistics
Solutions Mgr
GM
Group Director-
Distribution & Logistics
Group Director
Inbound Logistics
Operations Manager
Inbound Logistics Services
Manager
Inbound Operations
Manager
Internal Management
Consultant
Internal Management
Consultant
Inventory Planner
Latin America Operations
Manager
Latinoamerica Logistics
Manager
Leader, Best Practices
Leader, Best Practices
Logistics Analyst
Logistics Analyst
Logistics Development
Manager

Logistics Leader
Logistics Leader
Logistics Manager- Sr.
Consultant
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Manager
Logistics Mgr.-Supply
Planning G
Logistics Operations
Manager
Logistics Process Leader
Logistics Specialist
Logistics Supervisor
Logistics Supervisor
Logistics Systems Manager
Logistics/Customer
Services Manager
Logistics/Warehousing
Zone Manager
Manager- Customer
Service
Manager - Supply Chain
Manager
Manager
Manager
Manager Distribution
Manager of Corporate
Services
Manager of Distribution
and Materials
Manager of Distribution
and Warehousing
manager of logistics
Manager of Logistics
Worldwide
Manager of
Transportation/Logistics
Manager of
Transportation/Logistics

Manager Regional
Distribution
Manager Supply Chain
Logistics Systems
Manager, Corporate
Logistics
Manager, Corporate
Logistics
Manager, Distribution
Manager, Distribution
Manager, Distribution
Operations
Manager, Distribution
Operations
Manager, Logistics
Manager, Logistics
Manager, Manufacturing
Planning
Manager, Service
Operations
manager, Transportation
Manager, WWLogistics
Technologies
Materials Manager
Materials Manager
Mgr. Distribution Projects
Mgr. Field Operations
MIS Manager
Motor Analysis Manager
National Traffic &
Distribution Manger
National Traffic &
Distribution Manger
New Product Development
Manager
Operations Manager
Operations Manager
Planning Manager
PPC Company Facilitator
President
President
President
President
Procurement Manager
Procurement Manager
Product Manager
Product Support/Value
Project Manager - Logistics
& Compliance
Project Manager

Project Manager
Project Manager, Compliance and Logistics
Project Manager, Compliance and Logistics
Purchasing Administrative Coordinator
Regional Distribution Manager
Regional Distribution Manager
Regional Logistics Manager
Regional Logistics Manager
Regional Logistics Manager
Regional Logistics Mgr
Sales Logistics Manager-East
Senior Corporate Auditor
Senior Director of Customer Logistics
Senior Logistics Manager
Senior Manager
Senior Manager Logistics Services
Senior Manager Logistics Services
Senior Manager Operations
Senior Manager, Building Products IT
Senior Manager, Building Products IT
Senior Manager, Global Logistics
Senior Manager, Logistics/Parts
Sr Director - Supply Chain
sr director
Sr Director Logistics
Sr Director, Production Planning and Distribution
Sr Industrial Engineer
SR Logistics
SR Logistics
Sr VP
Sr VP Logistics
Sr VP Manufacturing and Logistics
Sr. Commodity Manager
Sr. Commodity Manager
Sr. Corporate Manager of Logistics/ Materials & Planning
Sr. Corporate Manager of Logistics/ Materials & Planning
Sr. Director Logistics
Sr. Director Product Supply
Sr. Director Product Supply
Sr. Logistics Manager
Sr. Logistics Manager
Sr. Logistics Specialist
Sr. Logistics Specialist
Sr. Manager, Global Logistics
Sr. Manager, Strategic Logistics
Sr. Traffic Specialist
Sr. VP Logistics & Distribution
Strategic Account Manager, Transportation and Logistics
Superintendent Shipping/Warehousing
Supervisor- Transportation Services
Supervisor- Transportation Services
Supply Chain Administrator
Supply Chain Engineer
Supply Chain Logistics Consulting
Supply Chain Manager
Supply Chain Manager
Supply Chain Manager
Supply Chain Manager
Team Leader, Special Businesses
Team Leader, Special Businesses
Traffic Manager
Traffic Manager
Traffic Planning Manager
Transportation Administrator/Corporate Sourcing
Transportation and Distribution Lead
Transportation Manager
Transportation Manager
Transportation Manager
V.P. Operations
V.P., Supply Chain Management
Vehicle Program Manager
Vice President - Logistics
Vice President
Vice President
Vice President
Vice President & Director Logistics
Vice President Grain & Logistics
Vice President of Logistics
Vice President of Supply Chain Mgmt.
Vice President, Logistics
Vice President, Operations
Vice President, Supply Chain
Vice President, Supply Chain
VP Chain Demand
VP Logistics
VP Logistics and Distribution
VP Operations
VP Operations and Logistics
VP Product Delivery
VP Sales and Marketing
VP, Custopmer Service & Logistics
VP, OPS
VP/GM
Warehouse Manager

DEMOGRAPHIC STATISTICS

Department Type

		Frequency	Percent	Valid Percent	Cumulative Percent
Missing		2	.7	.7	.7
	Marketing	5	1.7	1.7	2.4
	R&D	3	.3	.3	2.7
	Manufacturing	20	6.8	6.8	9.5
	Logistics	198	66.9	66.9	76.4
	New Products	4	1.4	1.4	77.7
	Sales	3	1.0	1.0	78.7
	Finance	1	.3	.3	79.1
	Other	62	20.9	20.9	100.0
	Total	296	100.0	100.0	

Number of New Products Respondent Were Involved With

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	.3	.4	.4
	2	6	2.0	2.2	2.5
	4	2	.7	.7	3.2
	5	14	4.7	5.0	8.2
	10	43	14.5	15.4	23.7
	15	18	6.1	6.5	30.1
	20	35	11.8	12.5	42.7
	25	22	7.4	7.9	50.5
	30	15	5.1	5.4	55.9
	35	7	2.4	2.5	58.4
	40	13	4.4	4.7	63.1
	50	13	4.4	4.7	67.7
	60	7	2.4	2.5	70.3
	65	4	1.4	1.4	71.7
	70	4	1.4	1.4	73.1
	75	8	2.7	2.9	76.0
	80	18	6.1	6.5	82.4
	85	11	3.7	3.9	86.4
	90	14	4.7	5.0	91.4
	94	1	.3	.4	91.8
	95	7	2.4	2.5	94.3
	99	2	.7	.7	95.0
	100	14	4.7	5.0	100.0
	Total	279	94.3	100.0	
Missing	System	17	5.7		
Total		296	100.0		

Primary Industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Missing		1	.3	.3	.3
	Food	52	17.6	17.6	17.9
	Chemicals	39	13.2	13.2	31.1
	Pharmaceutical	34	11.5	11.5	42.6
	Computers	53	17.9	17.9	60.5
	Transportation	13	4.4	4.4	64.9
	Metals	7	2.4	2.4	67.2
	Building Mat.	24	8.1	8.1	75.3
	Other	73	24.7	24.7	100.0
	Total	296	100.0	100.0	

Percent of Profits from Products less than 5 years old

		Frequency	Percent	Valid Percent	Cumulative Percent
Missing		17	5.7	5.7	5.7
	0	1	.3	.3	6.1
	10	43	14.5	14.5	20.6
	100	14	4.7	4.7	25.3
	15	18	6.1	6.1	31.4
	2	6	2.0	2.0	33.4
	20	35	11.8	11.8	45.3
	25	22	7.4	7.4	52.7
	30	15	5.1	5.1	57.8
	35	7	2.4	2.4	60.1
	4	2	.7	.7	60.8
	40	13	4.4	4.4	65.2
	5	14	4.7	4.7	69.9
	50	13	4.4	4.4	74.3
	60	7	2.4	2.4	76.7
	65	4	1.4	1.4	78.0
	70	4	1.4	1.4	79.4
	75	8	2.7	2.7	82.1
	80	18	6.1	6.1	88.2
	85	11	3.7	3.7	91.9
	90	14	4.7	4.7	96.6
	94	1	.3	.3	97.0
	95	7	2.4	2.4	99.3
	99	2	.7	.7	100.0
	Total	296	100.0	100.0	

Company Age

		Frequency	Percent	Valid Percent	Cumulative Percent
	<2 years	1	.3	.3	.3
	2-5 years	4	1.4	1.4	1.7
	6-10 years	10	3.4	3.4	5.1
	11-15 years	16	5.4	5.4	10.5
	16> years	264	89.2	89.5	100.0
	Total	295	99.7	100.0	
Missing	System	1	.3		
Total		296	100.0		

Employees Worldwide

	Employees	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<100	3	1.0	1.0	1.0
	101-500	10	3.4	3.4	4.4
	501-1000	12	4.1	4.1	8.5
	1001-5000	73	24.7	24.9	33.4
	5001-10000	36	12.2	12.3	45.7
	10001-50000	93	31.4	31.7	77.5
	>50001	66	22.3	22.5	100.0
	Total	293	99.0	100.0	
Missing	System	3	1.0		
Total		296	100.0		

World Wide Sales

	Sales ($Million)	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<10	2	.7	.7	.7
	11-99	11	3.7	3.8	4.5
	100-999	66	22.3	22.7	27.1
	1000-5000	83	28.0	28.5	55.7
	>6000	129	43.6	44.3	100.0
	Total	291	98.3	100.0	
Missing	System	5	1.7		
Total		296	100.0		

DESCRIPTIVE STATISTICS

		N	Mean	Std. Deviation	Skewness	Kurtosis
IT1	Minor Improvements	293	4.63	1.33	-.475	-.231
IT2	Market Familiar	293	2.75	1.65	.695	-.688
IT3	Developing Technology	293	3.72	1.77	.059	-1.145
PP1	NP Profit	293	4.41	1.42	-.417	-.325
PP2	NP Budget	293	4.26	1.26	-.101	-.315
PP3	NP Market Share	293	4.44	1.48	-.387	-.412
PP4	NP Customer satisfaction	293	4.97	1.25	-.858	.952
PP5	NP Competitive Advantage	293	4.94	1.26	-.457	-.081
PP6	NP Speed to Market	293	4.54	1.36	-.141	-.454
PP7	NP Quality/Performance	293	4.95	1.31	-.812	.501
CFI1	Work Together	293	5.22	1.39	-.805	.137
CFI2	Share Info	293	4.99	1.45	-.575	-.461
CFI3	Share resources	293	4.50	1.47	-.234	-.626
CFI4	Collective Goals	293	4.71	1.46	-.360	-.697
CFI5	Teamwork	293	5.04	1.41	-.574	-.337
LIT1	First Involvement	293	4.40	1.77	-.179	-1.063
LIM1	Idea Generation	293	1.51	1.18	2.952	9.013
LIM2	Idea Screening	293	1.61	1.24	2.486	6.313
LIM3	Market Analysis	293	1.80	1.36	2.001	3.692
LIM4	Development	293	2.57	1.71	.843	-.214
LIM5	Testing	293	3.05	1.93	.470	-1.061
LIM6	Launch	293	5.09	2.13	-.892	-.582
LIQ1	Creativity	293	3.67	1.78	-.023	-1.001
LIQ2	Independent contribution	293	3.85	1.71	-.305	-.912
LIQ3	ideas generated	293	3.62	1.72	-.053	-.986
LIQ4	ideas implemented	293	3.72	1.81	-.127	-1.150
LIQ5	Influential	293	3.48	1.85	.265	-1.033
LIQ6	directly impacted	293	3.90	1.98	-.046	-1.244
LIR1	Committed	293	4.85	1.94	-.886	-.325
LIR2	cooperative	293	4.96	1.88	-1.096	.133
LIR3	highly valued	293	4.17	1.92	-.269	-.996
LP1	Logistics costs	293	4.18	1.11	.087	.424
LP2	order fill rate	293	4.60	1.13	.029	-.011
LP3	On-time delivery	293	4.83	1.30	-.385	.151
LP4	Damage free	293	4.90	1.40	-.579	.228
LP5	Equipment utilization	293	4.59	1.26	-.095	.255
LP6	transit time	293	4.52	1.32	-.291	.495
DI1	Important	293	5.29	1.41	-.831	.330
DI2	Visibility	293	4.94	1.42	-.599	-.151
DI3	Access	293	5.09	1.50	-.629	-.351
DI4	decision making	293	4.75	1.38	-.576	-.155
AP1	cost advantage	293	5.05	1.34	-.940	.698

AP2	service quality advantage	293	5.42	1.29	-1.232	1.969
AP3	Logistics competitive advantage	293	5.09	1.42	-.810	.394
AP4	Logistics profitability	293	4.79	1.40	-.690	.266
EU1	env. rarely change marketing	293	3.94	1.66	-.030	-.943
EU2	Env product obsolescence	293	3.94	2.02	-.107	-1.397
EU3	env technology obsolescence	293	4.18	1.91	-.274	-1.133
EU4	env competitors actions	293	3.88	1.43	.025	-.664
EU5	env easy to forecast demand	293	2.86	1.33	.595	-.321
TQBC1	JIT	293	4.48	1.79	-.224	-1.044
TQBC2	VMI	293	4.22	1.69	-.115	-1.004
TQBC3	AR_CR	293	4.08	1.74	.041	-1.013
TQBC4	QR	293	4.41	1.76	-.245	-.917
TQBC5	ECR	293	3.86	1.88	-.006	-1.095
TQBC6	CFP	293	3.18	1.67	.381	-.614
GF1	Global sourcing	293	4.77	2.01	-.507	-1.120
GF2	Global competition	293	4.92	1.90	-.596	-.879
GF3	Global Manufacturing	293	4.80	1.96	-.520	-1.012
IIT1	EDI	293	5.45	1.46	-1.030	.653
IIT2	Internet	293	5.00	1.52	-.499	-.343
IIT3	E_commerce	293	4.18	1.62	.066	-.850
IIT4	Real Time Product Tracking	293	3.93	1.70	.065	-.971
IIT5	Supply Chain Information System	293	4.62	1.68	-.385	-.813
IIT6	ERP	293	5.07	1.58	-.705	-.144
IIT7	APS	293	4.70	1.60	-.472	-.561

Innovation Level

Communalities

	Initial	Extraction
IT1	1.000	.657
IT2	1.000	.314
IT3	1.000	.627

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.597	53.247	53.247	1.597	53.247	53.247
2	.856	28.524	81.771			
3	.547	18.229	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
IT1	.810
IT2	.560
IT3	.792

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

       N of Cases =        293.0
                                                       N of
Statistics for        Mean    Variance    Std Dev  Variables
      Scale        11.1092     11.9195     3.4525          3

Item Means            Mean     Minimum    Maximum      Range    Max/Min   Variance
                    3.7031      2.7543     4.6348     1.8805     1.6828      .8843


Item-total Statistics

               Scale          Scale      Corrected
               Mean         Variance       Item-         Squared          Alpha
              if Item        if Item       Total         Multiple        if Item
              Deleted        Deleted    Correlation    Correlation       Deleted

IT1            6.4744         7.0036       .4439          .2241           .3205
IT2            8.3549         7.0654       .2412          .0611           .6050
IT3            7.3891         5.5125       .3913          .2122           .3621


Reliability Coefficients      3 items

Alpha =    .5358          Standardized item alpha =    .5502
```

Project Performance

Communalities

	Initial	Extraction
PP1	1.000	.717
PP2	1.000	.516
PP3	1.000	.672
PP4	1.000	.684
PP5	1.000	.628
PP7	1.000	.623

Extraction Method: Principal Component Analysis.

Communalities

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.840	64.003	64.003	3.840	64.003	64.003
2	.704	11.734	75.736			
3	.522	8.697	84.433			
4	.431	7.179	91.612			
5	.280	4.668	96.279			
6	.223	3.721	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
PP1	.847
PP2	.718
PP3	.820
PP4	.827
PP5	.793
PP7	.789

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

        N of Cases =        293.0

                                                        N of
Statistics for        Mean    Variance     Std Dev   Variables
      Scale        27.9706     40.7658      6.3848           6

Item Means            Mean     Minimum     Maximum       Range     Max/Min    Variance
                    4.6618      4.2649      4.9658       .7008      1.1643       .1039


Item-total Statistics
```

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
PP1	23.5617	27.3638	.7686	.6485	.8553
PP2	23.7056	30.6462	.6089	.4013	.8808
PP3	23.5262	27.3345	.7279	.6117	.8629
PP4	23.0048	29.2939	.7330	.6079	.8622
PP5	23.0323	29.7172	.6914	.5155	.8685
PP7	23.0224	29.3557	.6819	.5583	.8698

Reliability Coefficients   6 items

Alpha =   .8866   Standardized item alpha =   .8868

Cross-Functional Integration

Communalities

	Initial	Extraction
CFI1	1.000	.831
CFI2	1.000	.867
CFI3	1.000	.779
CFI4	1.000	.834
CFI5	1.000	.664

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.975	79.502	79.502	3.975	79.502	79.502
2	.409	8.182	87.684			
3	.285	5.690	93.375			
4	.207	4.131	97.506			
5	.125	2.494	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix [a]

	Component
	1
CFI1	.911
CFI2	.931
CFI3	.882
CFI4	.913
CFI5	.815

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

```
R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

      N of Cases =        293.0

                                                    N of
Statistics for        Mean    Variance    Std Dev  Variables
      Scale        24.4761     40.9755     6.4012          5

Item Means            Mean     Minimum    Maximum      Range    Max/Min   Variance
                    4.8952      4.5017     5.2218      .7201     1.1600      .0817


Item-total Statistics

                 Scale         Scale      Corrected
                  Mean       Variance       Item-        Squared          Alpha
                if Item       if Item       Total        Multiple        if Item
                Deleted       Deleted    Correlation   Correlation       Deleted
```

CFI1	19.2543	26.7750	.8544	.7757	.9150
CFI2	19.4812	25.7984	.8845	.8081	.9089
CFI3	19.9744	26.5002	.8134	.6968	.9225
CFI4	19.7628	26.0334	.8585	.7476	.9139
CFI5	19.4317	28.1460	.7247	.5328	.9383

Reliability Coefficients 5 items

Alpha = .9350 Standardized item alpha = .9349

Logistics Involvement Magnitude

Communalities

	Initial	Extraction
LIM1	1.000	.744
LIM2	1.000	.823
LIM3	1.000	.717
LIM4	1.000	.441

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.724	68.099	68.099	2.724	68.099	68.099
2	.690	17.260	85.359			
3	.399	9.977	95.336			
4	.187	4.664	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
LIM1	.862
LIM2	.907
LIM3	.847
LIM4	.664

Extraction Method: Principal Component Analysis.
a 1 components extracted.

R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

N of Cases = 293.0

Statistics for	Mean	Variance	Std Dev	N of Variables
Scale	7.4915	19.9494	4.4665	4

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	1.8729	1.5119	2.5700	1.0580	1.6998	.2301

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
LIM1	5.9795	12.7119	.6914	.6399	.7570
LIM2	5.8805	11.9206	.7623	.7116	.7234
LIM3	5.6928	11.6108	.6991	.5223	.7449
LIM4	4.9215	11.3534	.4934	.2558	.8684

```
Reliability Coefficients     4 items

Alpha =   .8188           Standardized item alpha =   .8391
```

Logistics Involvement Quality

Communalities

	Initial	Extraction
LIQ1	1.000	.783
LIQ2	1.000	.830
LIQ3	1.000	.838
LIQ4	1.000	.804
LIQ5	1.000	.782
LIQ6	1.000	.733

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.769	79.490	79.490	4.769	79.490	79.490
2	.437	7.282	86.772			
3	.252	4.205	90.978			
4	.198	3.299	94.276			
5	.181	3.025	97.301			
6	.162	2.699	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
LIQ1	.885
LIQ2	.911
LIQ3	.916
LIQ4	.896
LIQ5	.884
LIQ6	.856

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)


        N of Cases =        293.0

                                                       N of
Statistics for        Mean    Variance    Std Dev  Variables
      Scale        22.2355     93.4409     9.6665          6

Item Means            Mean     Minimum    Maximum      Range    Max/Min   Variance
                    3.7059      3.4778     3.8976      .4198     1.1207      .0240


Item-total Statistics

                 Scale          Scale      Corrected
                  Mean       Variance       Item-          Squared           Alpha
                if Item       if Item       Total          Multiple         if Item
                Deleted       Deleted    Correlation     Correlation        Deleted
```

LIQ1	18.5666	66.2670	.8285	.7196	.9384
LIQ2	18.3823	66.3739	.8647	.7768	.9345
LIQ3	18.6177	66.1137	.8716	.7785	.9337
LIQ4	18.5154	65.3739	.8456	.7285	.9364
LIQ5	18.7577	65.1089	.8355	.7334	.9376
LIQ6	18.3379	64.2108	.7966	.6878	.9433

Reliability Coefficients 6 items

Alpha = .9472 Standardized item alpha = .9483

Logistics Involvement Relationship

Communalities

	Initial	Extraction
LIR1	1.000	.930
LIR2	1.000	.918
LIR3	1.000	.833

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.682	89.401	89.401	2.682	89.401	89.401
2	.242	8.082	97.483			
3	7.552E-02	2.517	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
LIR1	.965
LIR2	.958
LIR3	.913

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

        N of Cases =        293.0

                                                        N of
Statistics for        Mean    Variance    Std Dev   Variables
      Scale        13.9795     29.3763     5.4200           3

Item Means            Mean     Minimum    Maximum       Range     Max/Min    Variance
                    4.6598      4.1706     4.9556       .7850      1.1882       .1821


Item-total Statistics

                 Scale          Scale       Corrected
                  Mean        Variance        Item-          Squared          Alpha
                if Item        if Item        Total          Multiple        if Item
                Deleted        Deleted     Correlation     Correlation       Deleted

LIR1             9.1263        12.9052        .9145           .8696           .8823
LIR2             9.0239        13.4207        .9015           .8589           .8935
LIR3             9.8089        14.0113        .8143           .6650           .9602

Reliability Coefficients      3 items

Alpha =    .9403          Standardized item alpha =    .9404
```

Logistics Performance

Communalities

	Initial	Extraction
LP2	1.000	.460
LP3	1.000	.570
LP4	1.000	.492
LP5	1.000	.475
LP6	1.000	.416

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.413	48.263	48.263	2.413	48.263	48.263
2	1.000	19.998	68.261			
3	.687	13.732	81.992			
4	.563	11.267	93.260			
5	.337	6.740	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
LP2	.678
LP3	.755
LP4	.701
LP5	.689
LP6	.645

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

      N of Cases =        293.0

                                                        N of
Statistics for        Mean    Variance     Std Dev  Variables
      Scale        23.4389     19.9512      4.4667          5

Item Means            Mean     Minimum     Maximum      Range    Max/Min    Variance
                    4.6878      4.5232      4.8969      .3737     1.0826       .0268


Item-total Statistics

                 Scale          Scale      Corrected
                  Mean       Variance         Item-         Squared          Alpha
                if Item       if Item         Total        Multiple        if Item
                Deleted       Deleted    Correlation    Correlation        Deleted

LP2             18.8339       14.6634          .4613          .4006          .6954
```

LP3	18.6121	13.0917	.5478	.4388	.6607
LP4	18.5419	12.9117	.5029	.2713	.6795
LP5	18.8518	13.7076	.4965	.2770	.6813
LP6	18.9157	13.7800	.4493	.2897	.6999

Reliability Coefficients 5 items

Alpha = .7299 Standardized item alpha = .7309

Degree of Importance

Communalities

	Initial	Extraction
DI1	1.000	.778
DI2	1.000	.830
DI3	1.000	.846
DI4	1.000	.828

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.282	82.055	82.055	3.282	82.055	82.055
2	.331	8.283	90.338			
3	.239	5.977	96.315			
4	.147	3.685	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
DI1	.882
DI2	.911
DI3	.920
DI4	.910

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

       N of Cases =       293.0

                                                         N of
Statistics for         Mean    Variance    Std Dev   Variables
      Scale          20.0648    26.7526     5.1723           4

Item Means              Mean    Minimum    Maximum       Range    Max/Min   Variance
                      5.0162     4.7474     5.2935       .5461     1.1150      .0533

Item-total Statistics

               Scale          Scale       Corrected
               Mean         Variance        Item-        Squared          Alpha
              if Item        if Item        Total        Multiple        if Item
              Deleted        Deleted     Correlation   Correlation       Deleted

DI1           14.7713        15.8962        .7925         .6505           .9167
DI2           15.1263        15.3504        .8393         .7185           .9013
DI3           14.9795        14.6982        .8507         .7598           .8978
DI4           15.3174        15.7174        .8374         .7307           .9024
```

```
Reliability Coefficients     4 items

Alpha =    .9268           Standardized item alpha =    .9270
```

Advantage Provided

Communalities

	Initial	Extraction
AP1	1.000	.743
AP2	1.000	.742
AP3	1.000	.805
AP4	1.000	.751

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.041	76.017	76.017	3.041	76.017	76.017
2	.446	11.154	87.171			
3	.301	7.519	94.690			
4	.212	5.310	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
AP1	.862
AP2	.862
AP3	.897
AP4	.866

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
 R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

       N of Cases =       293.0
                                                          N of
Statistics for       Mean    Variance    Std Dev   Variables
      Scale       20.3447     22.5965     4.7536           4

Item Means           Mean     Minimum    Maximum       Range    Max/Min   Variance
                   5.0862      4.7884     5.4198       .6314     1.1319      .0672

Item-total Statistics

               Scale          Scale      Corrected
               Mean         Variance       Item-          Squared          Alpha
              if Item        if Item       Total         Multiple        if Item
              Deleted        Deleted    Correlation    Correlation       Deleted

AP1           15.2969        13.3876       .7528          .5837           .8692
AP2           14.9249        13.7341       .7512          .6132           .8702
AP3           15.2560        12.5062       .8050          .6760           .8495
AP4           15.5563        13.0011       .7597          .6046           .8669


Reliability Coefficients       4 items

Alpha =    .8946          Standardized item alpha =    .8947
```

Environmental Uncertainty

Communalities

	Initial	Extraction
EU1	1.000	.433
EU2	1.000	.668
EU3	1.000	.622
EU4	1.000	.467
EU5	1.000	.334

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.524	50.477	50.477	2.524	50.477	50.477
2	.781	15.616	66.093			
3	.706	14.113	80.206			
4	.645	12.892	93.097			
5	.345	6.903	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
EU1	.658
EU2	.818
EU3	.789
EU4	.683
EU5	.578

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

      N of Cases =         293.0

                                                          N of
Statistics for        Mean    Variance      Std Dev   Variables
      Scale        18.7986     35.8668       5.9889          5

Item Means            Mean     Minimum      Maximum       Range     Max/Min    Variance
                    3.7597      2.8635       4.1775      1.3140      1.4589       .2642


Item-total Statistics

               Scale          Scale       Corrected
               Mean          Variance       Item-          Squared            Alpha
              if Item        if Item        Total          Multiple          if Item
              Deleted        Deleted     Correlation     Correlation         Deleted

EU1          14.8567        25.3698         .4652           .2192              .7283
EU2          14.8601        19.9906         .6533           .4792              .6547
EU3          14.6212        21.3731         .6163           .4511              .6708
```

EU4	14.9215	26.6000	.4919	.2428	.7208
EU5	15.9352	28.5198	.3927	.1663	.7497

Reliability Coefficients 5 items

Alpha = .7533 Standardized item alpha = .7493

Time and Quality Based Competition

Communalities

	Initial	Extraction
TQBC2	1.000	.517
TQBC3	1.000	.571
TQBC4	1.000	.604
TQBC5	1.000	.686
TQBC6	1.000	.603

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.981	59.616	59.616	2.981	59.616	59.616
2	.720	14.401	74.017			
3	.651	13.018	87.035			
4	.359	7.179	94.214			
5	.289	5.786	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component 1
TQBC2	.719
TQBC3	.756
TQBC4	.777
TQBC5	.828
TQBC6	.777

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)
        N of Cases =       293.0
                                                            N of
Statistics for        Mean    Variance     Std Dev    Variables
      Scale        19.7440     45.6021      6.7529            5

Item Means            Mean     Minimum     Maximum       Range     Max/Min    Variance
                    3.9488      3.1843      4.4061      1.2218      1.3837       .2229

Item-total Statistics
                  Scale          Scale       Corrected
                   Mean       Variance         Item-            Squared             Alpha
                if Item        if Item         Total           Multiple           if Item
                Deleted        Deleted      Correlation       Correlation          Deleted

TQBC2           15.5256        31.9420         .5666              .3749              .8133
TQBC3           15.6655        30.8193         .6110              .4504              .8013
TQBC4           15.3379        30.1971         .6341              .4763              .7948
TQBC5           15.8874        28.1619         .6969              .5580              .7759
TQBC6           16.5597        30.9939         .6335              .4769              .7953

Reliability Coefficients      5 items
Alpha =    .8304          Standardized item alpha =    .8299
```

Global Factors

Communalities

	Initial	Extraction
GF1	1.000	.837
GF2	1.000	.841
GF3	1.000	.877

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.555	85.161	85.161	2.555	85.161	85.161
2	.257	8.581	93.742			
3	.188	6.258	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
GF1	.915
GF2	.917
GF3	.936

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

      N of Cases =        293.0

                                                        N of
Statistics for        Mean    Variance    Std Dev   Variables
      Scale        14.4812     29.3121     5.4141           3

Item Means            Mean     Minimum    Maximum       Range     Max/Min    Variance
                    4.8271      4.7679     4.9181       .1502      1.0315       .0064


Item-total Statistics

                 Scale          Scale      Corrected
                  Mean       Variance         Item-        Squared          Alpha
                if Item       if Item         Total       Multiple        if Item
                Deleted       Deleted    Correlation    Correlation        Deleted

GF1              9.7133       13.3970         .8102          .6619          .8866
GF2              9.5631       14.1167         .8128          .6681          .8841
GF3              9.6860       13.2778         .8511          .7247          .8516


Reliability Coefficients     3 items

Alpha =    .9126          Standardized item alpha =    .9128
```

Improving Information Technology

Communalities

	Initial	Extraction
IIT2	1.000	.470
IIT3	1.000	.581
IIT4	1.000	.572
IIT5	1.000	.656
IIT6	1.000	.436
IIT7	1.000	.471

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.187	53.109	53.109	3.187	53.109	53.109
2	.921	15.348	68.457			
3	.628	10.474	78.931			
4	.533	8.889	87.820			
5	.408	6.794	94.614			
6	.323	5.386	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix

	Component
	1
IIT2	.685
IIT3	.763
IIT4	.756
IIT5	.810
IIT6	.660
IIT7	.686

Extraction Method: Principal Component Analysis.
a 1 components extracted.

```
  R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

       N of Cases =        293.0

                                                         N of
Statistics for        Mean    Variance    Std Dev   Variables
      Scale        27.5017     49.7919     7.0563           6

Item Means            Mean     Minimum    Maximum       Range     Max/Min    Variance
                    4.5836      3.9317     5.0717      1.1399      1.2899       .2028


Item-total Statistics

              Scale          Scale      Corrected
              Mean         Variance       Item-          Squared          Alpha
             if Item        if Item       Total          Multiple        if Item
```

	Deleted	Deleted	Correlation	Correlation	Deleted
IIT2	22.5051	37.5043	.5380	.4369	.8047
IIT3	23.3242	35.1582	.6260	.4891	.7864
IIT4	23.5700	34.4720	.6212	.3948	.7874
IIT5	22.8771	33.5602	.6909	.5124	.7715
IIT6	22.4300	37.3898	.5145	.3385	.8096
IIT7	22.8020	36.7415	.5430	.3177	.8039

Reliability Coefficients 6 items

Alpha = .8226 Standardized item alpha = .8217

APPENDIX IV

STRUCTURAL EQUATION MODELS

Fit Statistics for Initial Model

```
Fit Measures

Fit Measure     Default model  Saturated      Independence           Macro
Discrepancy     2907.4703      0.0000 11627.8557             CMIN
Degrees of freedom      1317    0       1378            DF
P       0.0000          0.0000          P
Number of parameters    114     1431    53              NPAR
Discrepancy / df        2.2076          8.4382          CMINDF

RMR     0.4836  0.0000  0.8038          RMR
GFI     0.7340  1.0000  0.2491          GFI
Adjusted GFI    0.7109          0.2202          AGFI
Parsimony-adjusted GFI 0.6755           0.2399          PGFI

Normed fit index        0.7500  1.0000  0.0000          NFI
Relative fit index      0.7384          0.0000          RFI
Incremental fit index   0.8457  1.0000  0.0000          IFI
Tucker-Lewis index      0.8376          0.0000          TLI
Comparative fit index   0.8448  1.0000  0.0000          CFI

Parsimony ratio         0.9557  0.0000  1.0000          PRATIO
Parsimony-adjusted NFI 0.7168   0.0000  0.0000          PNFI
Parsimony-adjusted CFI 0.8074   0.0000  0.0000          PCFI

Noncentrality parameter estimate        1590.4703       0.0000  10249.8557              NCP
     NCP lower bound    1438.2526       0.0000  9909.0687               NCPLO
     NCP upper bound    1750.3607       0.0000  10597.1863              NCPHI
FMIN    9.8558  0.0000  39.4165         FMIN
F0      5.3914  0.0000  34.7453         F0
     F0 lower bound     4.8754  0.0000  33.5901         F0LO
     F0 upper bound     5.9334  0.0000  35.9227         F0HI
RMSEA   0.0640          0.1588          RMSEA
     RMSEA lower bound 0.0608           0.1561          RMSEALO
     RMSEA upper bound 0.0671           0.1615          RMSEAHI
P for test of close fit         0.0001          0.0000          PCLOSE

Akaike information criterion (AIC)      3135.4703       2862.0000       11733.8557
     AIC
Browne-Cudeck criterion         3186.5574       3503.2780       11757.6068              BCC
Bayes information criterion     4008.7845       13824.3921      12139.8702              BIC
Consistent AIC 3670.1712        9573.9044       11982.4448              CAIC
Expected cross validation index         10.6287 9.7017  39.7758         ECVI
     ECVI lower bound 10.1127 9.7017    38.6206         ECVILO
     ECVI upper bound 11.1707 9.7017    40.9532         ECVIHI
MECVI   10.8019 11.8755 39.8563         MECVI

Hoelter .05 index       143             38              HFIVE
Hoelter .01 index       147             39              HONE
```

Fit Statistics 2nd Iteration

```
Fit Measure    Default model  Saturated      Independence          Macro
Discrepancy    2610.0313      0.0000 10667.4811             CMIN
Degrees of freedom     1168   0      1225          DF
P      0.0000          0.0000        P
Number of parameters   107    1275   50            NPAR
Discrepancy / df       2.2346        8.7081        CMINDF

RMR     0.4756 0.0000 0.8144         RMR
GFI     0.7452 1.0000 0.2514         GFI
Adjusted GFI   0.7218        0.2209         AGFI
Parsimony-adjusted GFI 0.6826        0.2416        PGFI

Normed fit index       0.7553 1.0000 0.0000        NFI
Relative fit index     0.7434        0.0000        RFI
Incremental fit index  0.8482 1.0000 0.0000        IFI
Tucker-Lewis index     0.8398        0.0000        TLI
Comparative fit index  0.8473 1.0000 0.0000        CFI

Parsimony ratio        0.9535 0.0000 1.0000        PRATIO
Parsimony-adjusted NFI 0.7202 0.0000 0.0000        PNFI
Parsimony-adjusted CFI 0.8079 0.0000 0.0000        PCFI

Noncentrality parameter estimate     1442.0313     0.0000 9442.4811             NCP
     NCP lower bound   1297.7561     0.0000 9115.8835              NCPLO
     NCP upper bound   1593.9859     0.0000 9775.6138              NCPHI
FMIN    8.8476 0.0000  36.1610       FMIN
F0      4.8882 0.0000  32.0084       F0
     F0 lower bound    4.3992 0.0000 30.9013       F0LO
     F0 upper bound    5.4033 0.0000 33.1377       F0HI
RMSEA   0.0647         0.1616        RMSEA
     RMSEA lower bound 0.0614        0.1588        RMSEALO
     RMSEA upper bound 0.0680        0.1645        RMSEAHI
P for test of close fit       0.0001        0.0000        PCLOSE

Akaike information criterion (AIC)   2824.0313     2550.0000     10767.4811
       AIC
Browne-Cudeck criterion       2868.7608     3082.9918     10788.3827          BCC
Bayes information criterion   3637.4862     12243.0376    11147.6002          BIC
Consistent AIC 3325.8997      8530.2083     11001.9990           CAIC
Expected cross validation index      9.5730 8.6441 36.4999       ECVI
     ECVI lower bound  9.0839 8.6441 35.3928       ECVILO
     ECVI upper bound  10.0881 8.6441 37.6292      ECVIHI
MECVI   9.7246 10.4508 36.5708       MECVI

Hoelter .05 index      142           37            HFIVE
Hoelter .01 index      146           38            HONE
```

Fit Statistics 3rd Iteration

```
Fit Measure    Default model  Saturated     Independence         Macro
Discrepancy    2611.9523      0.0000  10667.4811          CMIN
Degrees of freedom      1169    0       1225         DF
P      0.0000           0.0000          P
Number of parameters    106     1275    50           NPAR
Discrepancy / df        2.2343          8.7081       CMINDF

RMR     0.4752  0.0000  0.8144          RMR
GFI     0.7451  1.0000  0.2514          GFI
Adjusted GFI    0.7219          0.2209        AGFI
Parsimony-adjusted GFI 0.6831          0.2416       PGFI

Normed fit index        0.7551  1.0000  0.0000       NFI
Relative fit index      0.7434          0.0000       RFI
Incremental fit index   0.8481  1.0000  0.0000       IFI
Tucker-Lewis index      0.8399          0.0000       TLI
Comparative fit index   0.8472  1.0000  0.0000       CFI

Parsimony ratio         0.9543  0.0000  1.0000       PRATIO
Parsimony-adjusted NFI  0.7206  0.0000  0.0000       PNFI
Parsimony-adjusted CFI  0.8085  0.0000  0.0000       PCFI

Noncentrality parameter estimate        1442.9523    0.0000  9442.4811          NCP
     NCP lower bound    1298.6200       0.0000  9115.8835         NCPLO
     NCP upper bound    1594.9592       0.0000  9775.6138         NCPHI
FMIN    8.8541  0.0000  36.1610         FMIN
F0      4.8914  0.0000  32.0084         F0
     F0 lower bound     4.4021  0.0000  30.9013      F0LO
     F0 upper bound     5.4066  0.0000  33.1377      F0HI
RMSEA   0.0647          0.1616          RMSEA
     RMSEA lower bound  0.0614          0.1588       RMSEALO
     RMSEA upper bound  0.0680          0.1645       RMSEAHI
P for test of close fit         0.0001        0.0000      PCLOSE

Akaike information criterion (AIC)     2823.9523     2550.0000     10767.4811
       AIC
Browne-Cudeck criterion         2868.2637     3082.9918     10788.3827          BCC
Bayes information criterion     3629.8048     12243.0376    11147.6002          BIC
Consistent AIC 3321.1304        8530.2083     11001.9990         CAIC
Expected cross validation index        9.5727  8.6441  36.4999        ECVI
     ECVI lower bound   9.0835  8.6441  35.3928      ECVILO
     ECVI upper bound   10.0880 8.6441  37.6292      ECVIHI
MECVI   9.7229  10.4508 36.5708         MECVI

Hoelter .05 index       142             37           HFIVE
Hoelter .01 index       146             38           HONE
```

Fit Statistics 4th Iteration

```
Fit Measure     Default model  Saturated      Independence          Macro
Discrepancy     2486.8260      0.0000 10667.4811             CMIN
Degrees of freedom     1168    0      1225          DF
P       0.0000         0.0000         P
Number of parameters   107     1275   50            NPAR
Discrepancy / df       2.1291         8.7081        CMINDF

RMR     0.4181  0.0000 0.8144         RMR
GFI     0.7566  1.0000 0.2514         GFI
Adjusted GFI    0.7343         0.2209        AGFI
Parsimony-adjusted GFI 0.6931         0.2416        PGFI

Normed fit index       0.7669 1.0000 0.0000        NFI
Relative fit index     0.7555        0.0000        RFI
Incremental fit index  0.8612 1.0000 0.0000        IFI
Tucker-Lewis index     0.8535        0.0000        TLI
Comparative fit index  0.8603 1.0000 0.0000        CFI

Parsimony ratio        0.9535 0.0000 1.0000        PRATIO
Parsimony-adjusted NFI 0.7312 0.0000 0.0000        PNFI
Parsimony-adjusted CFI 0.8203 0.0000 0.0000        PCFI

Noncentrality parameter estimate      1318.8260      0.0000  9442.4811             NCP
     NCP lower bound   1179.1391      0.0000  9115.8835            NCPLO
     NCP upper bound   1466.2190      0.0000  9775.6138            NCPHI
FMIN    8.4299  0.0000  36.1610       FMIN
F0      4.4706  0.0000  32.0084       F0
     F0 lower bound    3.9971  0.0000  30.9013        F0LO
     F0 upper bound    4.9702  0.0000  33.1377        F0HI
RMSEA   0.0619         0.1616         RMSEA
     RMSEA lower bound 0.0585         0.1588        RMSEALO
     RMSEA upper bound 0.0652         0.1645        RMSEAHI
P for test of close fit       0.0001        0.0000        PCLOSE

Akaike information criterion (AIC)    2700.8260      2550.0000      10767.4811
       AIC
Browne-Cudeck criterion       2745.5555      3082.9918      10788.3827             BCC
Bayes information criterion   3514.2809      12243.0376     11147.6002             BIC
Consistent AIC 3202.6944      8530.2083      11001.9990            CAIC
Expected cross validation index       9.1553  8.6441  36.4999        ECVI
     ECVI lower bound  8.6818  8.6441  35.3928        ECVILO
     ECVI upper bound  9.6550  8.6441  37.6292        ECVIHI
MECVI   9.3070  10.4508 36.5708       MECVI

Hoelter .05 index      149            37            HFIVE
Hoelter .01 index      153            38            HONE
```

Fit Statistics for Final Model

```
Discrepancy              1539.1577      0.0000 8706.7775      CMIN
Degrees of freedom       813            0      861     DF
P                        0.0000         0.0000         P
Number of parameters     90       903   42             NPAR
Discrepancy / df         1.8932         10.1124        CMINDF

RMR      0.2302  0.0000  0.6161         RMR
GFI      0.8117  1.0000  0.2785         GFI
Adjusted GFI   0.7909         0.2433         AGFI
Parsimony-adjusted GFI 0.7308           0.2656         PGFI

Normed fit index         0.8232  1.0000 0.0000         NFI
Relative fit index       0.8128         0.0000         RFI
Incremental fit index    0.9080  1.0000 0.0000         IFI
Tucker-Lewis index       0.9020         0.0000         TLI
Comparative fit index    0.9074  1.0000 0.0000         CFI

Parsimony ratio          0.9443  0.0000 1.0000         PRATIO
Parsimony-adjusted NFI   0.7773  0.0000 0.0000         PNFI
Parsimony-adjusted CFI   0.8569  0.0000 0.0000         PCFI

Noncentrality parameter estimate       726.1577       0.0000  7845.7775          NCP
     NCP lower bound   619.3057        0.0000 7549.7586          NCPLO
     NCP upper bound   840.7994        0.0000 8148.2953          NCPHI
FMIN     5.2175  0.0000  29.5145        FMIN
F0       2.4616  0.0000  26.5959        F0
     F0 lower bound    2.0993  0.0000  25.5924        F0LO
     F0 upper bound    2.8502  0.0000  27.6213        F0HI
RMSEA   0.0550           0.1758         RMSEA
     RMSEA lower bound 0.0508          0.1724         RMSEALO
     RMSEA upper bound 0.0592          0.1791         RMSEAHI
P for test of close fit        0.0252         0.0000     PCLOSE

Akaike information criterion (AIC)    1719.1577      1806.0000      8790.7775
       AIC
Browne-Cudeck criterion        1749.8720      2114.1667      8805.1108          BCC
Bayes information criterion    2387.6804      8513.5103      9102.7547          BIC
Consistent AIC 2141.2901       6041.3946      8987.7726      CAIC
Expected cross validation index        5.8277  6.1220  29.7992       ECVI
     ECVI lower bound 5.4654  6.1220  28.7958       ECVILO
     ECVI upper bound 6.2163  6.1220  30.8247       ECVIHI
MECVI    5.9318  7.1667  29.8478       MECVI

Hoelter .05 index        169            32             HFIVE
Hoelter .01 index        175            33             HONE
```

VITA

Zach George Zacharia was born in Tiruvalla, Kerala on July 14, 1961. He moved to Canada in 1969 where he attended public school in Calgary, Edmonton and Ponoka. He graduated from Ponoka Composite High School in June 1979. He entered the B.S. program in Biology at the University of Alberta from September 1979 to April 1980 and Red Deer College from September 1980 to April 1981. In 1981 he entered the engineering program at the University of Calgary from September 1981 to April 1985 where he earned a B.S. degree in Mechanical Engineering.

Upon graduation he joined Alberta Transportation and Utilities as an Equipment Engineer for Equipment Supply and Services Branch. In 1988, after receiving his professional engineering license, he joined the part time MBA program in the University of Alberta while working full time. In 1990, he accepted a position as an Advanced Concepts Engineer at the R&D branch at Alberta Transportation and Utilities.

In April 1993 he graduated from the University of Alberta with an MBA. In July of 1995, he accepted a senior research associate position at the Transportation Research Center in the University of Tennessee. In August 1996, he joined the Ph.D. program in the University of Tennessee while working full time at the Transportation Center where he became an Associate Director.

In August of 2001, he graduated with his Ph.D. in Business Administration with a major in Logistics and Transportation and a minor in Marketing. He is currently employed as an Assistant Professor at Texas Christian University in Fort Worth, Texas.